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ARMA DIVISION
GARDEN CITY, NEW YORK

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AMERICAN BOSCH ARMA CORPORATION

DG-E531-323

**FINAL REPORT
TERNE**

CONTRACT N 140(122)69961B

Prepared by: Naval Projects Section

Date: 30 April 1963

ARMA DIVISION
AMERICAN ESSO ARMA CORPORATION



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ABSTRACT

This document is the final report of the system integration effort performed by the Arma Division, American Bosch Arma Corporation under Contract N140(122)69961B, in furnishing technical assistance to U. S. Naval Underwater Ordnance Station to provide the DE1035 and DE1036 with ASW Weapon System MK 1 Mod 0. This system combines the Norwegian TERNE ASW System with U. S. Fire Control System MK 105. This report, which fulfills a contractual requirement, is a summary of the services and equipment furnished under the contract.

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Section 1

INTRODUCTION

1.1 PURPOSE.

This report describes the work performed by the Arma Division, American Bosch Arma Corporation, during the period 1 March 1960 to 30 April 1963, under Contract N140(122)69961B. Under this contract, Arma provided technical assistance to the U.S. Naval Underwater Ordnance Station, Newport, R.I., for the integration of the Norwegian Terne III ASW system with Fire Control System MK 105 into DE 1035 and DE 1036. The integrated System was designated ASW Weapon System MK 1 Mod 0.

The ASW Weapon System MK 1 Mod 0 is described completely in ordnance documents NAVWEPS OD 15104, ASW Weapon System MK 1 Mod 0, Volume I, and in the System General Data and Maintenance book, Volume II.

Figure 1.1 shows the component equipments and their basic element relationships. The equipments are described in the system data book, Volume II.

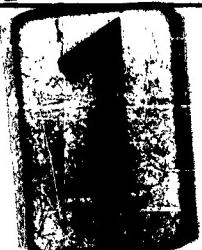
1.2 BACKGROUND.

The Terne III ASW System was developed by the Norwegian Defense Research Establishment with the assistance of the Royal Norwegian Navy and the United States Mutual Weapons Development Program. The project had its inception in Norway in 1954 under MWDP Contract and funding (U. S. Department of State).

It is a complete location-prediction system, intended for use in 1000-2000 ton anti-submarine escorts. The Norwegian system consists of two independent searchlight sonars, one for search and one for attack, a fully automatic predictor and a six-barrelled launcher. The projectiles are rocket-propelled depth charges containing a combined acoustic proximity and a time fuze.

ASSOCIATED EQUIPMENT	SUBSYSTEM I TARGET LOCALIZATION	SUBSYS CONT
⚓ Gyrocompass Mk 19	⚓ Stabilization Computer Mk 108	❖ Analog Comp
⚓ Speed Log System	⚓ AN/SQS-31, 32 Sonar	❖ Position Indic
⚓ Wind Indicating Equipment	❖ AN/SQA-16 (XN-1) Sonar	❖ Firing Panel
		❖ Indicator Panel
		⚓ Attack Directo
		⚓ Bearing Indic
		⚓ Ship's Course
		⚓ Target Course
		⚓ Angle Solver
		⚓ Torpedo Cours
		Mk 3 (2)
		⚓ Autoplotter
		⚓ Torpedo Direct
⚓ Navy Equipment		❖ Power Distrib
⚓ Navy Equipment for Torpedoes Mk 44 and Mk 46		MK 26I Mod
⚓ Navy Equipment for Torpedo Mk 37 Mod 1		⚓ Control Panel
❖ Terne Equipment		❖ Firing Panel
▲ Arma Equipment		▲ Electronic Fre
□ Modified Equipment		Mk 50 Mod 0
T-DD Tele-Dynamics Division		▲ Control Panel
		T-DD UBFC S

FIGURE I.I COMPONENT EQUIPMENTS OF A



WEAPON SYSTEM

SUBSYSTEM 2 CONTROL	SUBSYSTEM 3 WEAPON DELIVERY	SUBSYSTEM 4 WEAPONS
<ul style="list-style-type: none"> * Analog Computer Mk 142 Mod 0 * Position Indicator Mk 99 Mod 0 * Firing Panel Mk 262 Mod 0 * Indicator Panel Mk 263 Mod 0 ⚓ Attack Director Mk 5 Mod 3 ⚓ Bearing Indicator Mk 22 ⚓ Ship's Course Indicator Mk 6 ⚓ Target Course Projector ⚓ Angle Solver Mk 17 Mod 2 ⚓ Torpedo Course Indicator Mk 3 (2) ⚓ Autoplotter Mk 20 ⚓ Torpedo Director Mk 37 Mod 1 * Power Distribution Panel MK261 Mod 0 ⚓ Control Panel Mk 73 Mod 5 ⚓ Firing Panel Mk 39(Modified) ▲ Electronic Frequency Converter Mk 50 Mod 0 ▲ Control Panel Mk 264 Mod 0 T-DD UBFC Switchboard 	<ul style="list-style-type: none"> * Loading House and Loading Equipment * Dud-Jettisoning Equipment * Rocket-Thrown Depth Charge Launcher Mk 117 Mod 0 ⚓ Torpedo Tube Mk 32 (2) * Torpedo Tube Mk 25 (2)* * Depth Charge Release Track Mk 9 	<ul style="list-style-type: none"> * Rocket-Thrown Depth Charge Mk 3 Mod 0 ⚓ Torpedoes: Mk 44 Mods 0, 1, 2, 3, 4 Mk 46 Mod 0 ⚓ Torpedo Mk 37 Mod 1* ⚓ Depth Charge Mk 9, Mk 14

* Not Installed Concurrently With Terne

EQUIPMENTS OF ASW WEAPON SYSTEM MK I MOD 0

2

1.2.1 OPDEVFOR Evaluation in a Norwegian Ship

A preliminary limited evaluation was conducted by Commander Operational Development Force on the Terne prototype system from 9 September 1958 to 9 October 1958 aboard KNM Balder, a 700-ton coastal escort of the Royal Norwegian Navy, off Key West, Florida. This evaluation generally recognized the potential effectiveness, simplicity, lightweight, and compact design of Terne.

1.2.2 Prior Contractual Effort

There were two study contracts which preceded Contract N140(122)69961B. These were N140(122)68624B and N140(122)69074B.

Contract N140(122)68624B: Term; 27 August 1959 - 15 March 1960.
In 1959, the Bureau of Ordnance assigned to NUOS under Task Assignment 483-534/44009/04070, the task of determining the cost and feasibility of Terne III for ships of the DE1033 class. Arma provided technical assistance to NUOS under Contract N140(122)68624B as follows:

"Furnish engineering services to investigate the feasibility of adopting a Norwegian Terne III ASW weapons system aboard vessels of the U.S. Navy. The services to consist of two phases:

- (a) Assist in preparation of a study report by the Navy Underwater Ordnance Station relative to DE1033 Class vessels, and
- (b) Concluding with written recommendations of what further studies should be performed on the feasibility of adapting the Terne III ASW System or components to existing and planned weapon systems of the U.S. Navy."

The results of this contract were documented in NUOS Consecutive Report 296, "Cost and Feasibility Study of Incorporating Terne III ASW System in Vessels of the DE1033 Class," dated 14 September 1959.

The report presented cost and feasibility data for five possible system configurations and recommended for U.S. Navy use, "System 2a." System 2a consisted of the AN/SQS-4 Sonar (Plus RDT), Terne Attack Sonar (for target depth only), Fire Control System MK 105 modified for Terne and the Terne Launcher and Loading Equipments. This system was recommended because it

- ... made maximum utilization of proven U.S. equipments.
- ... was a proven system for weapons other than Terne.
- ... was similar to FCS MK 105 in the fleet and thereby minimized logistics and training information.
- ... provided target depth information.
- ... handled SCB ordnance requirements.
- ... should be more easily adaptable to new weapons, such as long range wire-guided torpedoes.

Contract N140(122)69074B: Term; 30 November 1959 to 17 April 1960.
Under Contract N140(122)69074B technical assistance was provided to NUOS to

"... specifically define the scope of engineering design and technical development necessary to permit the incorporation of the Terne III ASW System (from Kongsberg Vaapenfabrikk, Norway) to implement the designated 'System 2a' aboard the DE1035 and DE1036. The engineering services shall further be utilized to provide assistance to Naval Underwater Ordnance Station in preparing the following reports

- ... Phase Plan
- ... Technical Development Plan
- ... Documentation Survey"

Phase Plan. The Phase Plan, documented as "Terne III Missile Program Phasing Schedule" (BuOrd Task Assignments No. 417064/42022/01070 and 60070) defined the detailed scheduling required for the complete program including conduct of studies, equipment procurement, installation and all related documentation. The Phase Plan was delivered 9 December 1959.

At a conference at Kongsberg Vaapenfabrikk (KV), Norway, 14-18 December 1959; an alternative system was proposed by KV using the Terne Fire Control Computer instead of Computer MK 68, Computer MK 59 and Power Supply MK 88 of "System 2a". The use of the Terne computer had not been previously recommended in "System 2a" mainly because of its functional incompatibility with the Attack Director MK 5. During the conference, it was disclosed that the Terne computer had already been modified by the Norwegians so that, with relatively simple changes, it could be used with proper converters directly with the Attack Director MK 5. The resultant system, a "modified System 2a," became the system about which the Detailed Technical Plan and Documentation Survey were prepared.

Technical Development Plan. This document indicated the proposed techniques, annual funding and time phasing for the development and integration of System 2a (as modified at the December 1959 conference). The document was prepared in accordance with ONR Instruction 3910.1, 17 December 1957; "Instructions for Preparation of an R & D Technical Development Plan."

The Technical Development Plan (TDP) was based on CNO NTX 171953Z, November 1959, which amended SCB Project 131 so that the Hedgehog ASW weapon was removed and replaced by the Norwegian Terne III ASW weapon. This weapon system was originally designated as Weapon System W-113. The TDP set forth the performance characteristics and effectiveness of the weapon system and presented time schedules and funding requirements to

... provide Weapon System Development Coordination

... procure Norwegian components

- ... define requirements and engineer for service application; the equipments and modifications necessary to integrate Norwegian components
- ... provide engineering assistance for installation, checkout, OPTEVFOR evaluation and bridge-the-gap training.

The schedules set forth the activity responsible for system development, funding requirements for development, equipment procurement, documentation, installation, field and shop tests and personnel training. The TDP also described the system operation, the complete developmental aspects, reviewed the characteristics of associated systems, and set up manning requirements. The TDP was completed and delivered on 24 February 1960 to NUOS.

Documentation Survey. The third task under this contract, preparation of the documentation survey, was completed 13 January, 1960 and resulted in a document entitled; "Recommended Documentation for the Weapon System W-113 Aboard the DE1035 and 1036 Vessels." It contains the documentation requirement for each item to be procured for Weapon System W-113. It prescribed the minimum documentation for items to be procured from KV. This minimum documentation was limited to that required for equipment installation and maintenance. This document also contains a "Summary of Budgetary Cost of Documentation Recommended for ASW Weapon System W-113 Aboard the DE1035 and DE1036 Vessels."

In addition to these three items of documentation required by this contract; at the request of NUOS a document entitled "Technical Requirements for Procuring of Norwegian Components for Weapon System W-113 (Terne III ASW System)" was prepared and furnished to NUOS on 14 January 1960. It was later revised as a result of visit by NUOS to NPO, London, England; with final copy dated 26 January 1960, forwarded to NUOS. The final document prescribed the number of each type of Norwegian equipment to be procured from KV. It specified the modifications required to each equipment to render it satisfactory for use on the DE1035 and DE1036 vessels. It also contained a section outlining the final documentation to be supplied by KV for each equipment.

Section . 2

CONTRACT N140(122) 69961B

2.1 GENERAL

This section of the report describes the contract requirements and the related modifications.

In response to NPO Brooklyn RFP Q7463, Arma proposal letter JN-A431-C1581 of 24 March 1960 submitted a technical proposal, "System Integration for Weapon System W-113," Arma Document A60-7. Contract negotiations began 1 June 1960 and concluded when the fully executed contract N140(122)69961B was received in September 1960, with provisions for authorization of costs incurred beginning 1 March 1960. For funding purposes, the work statement was set forth in two phases, Phase I and Phase II. (Items covered by Phase I are indicated by an asterisk in the list of items of the Statement of Work, paragraph 2.3. Phase II items are indicated by a double asterisk.)

Authorization was received 23 June 1960 (NPO Brooklyn letter P3:db N140(122)69961B) to commence Phase I and at which time an option for Phase II was indicated also. The Phase II option was exercised by the Government by Contract Modification 1, dated 2 November 1960.

2.2 PARTICIPANTS IN THE PROGRAM

The principal participants in the program are shown on the chart, Figure 2-1.

Program management was under cognizance of the Naval Underwater Ordnance Station. Mr. Leo F. Risko was Program Manager, who was succeeded later by Mr. F. W. Kamph. Mr. R. Frey, Code 603, was Project Manager at BuShips, with Mr. D. Wagner, Code 689C, having cognizance over the TERNE sonar and Mr. E. Garrison, Code 665F, over the UBFC switchboard for the DE 1035 and DE 1036 vessels. Installation design at Long Beach Naval Shipyard was under cognizance of Mr. J. R. Cole, Project Manager; with the system checkout under cognizance of Chief Ordnance Engineer, Mr. Logan Colby.

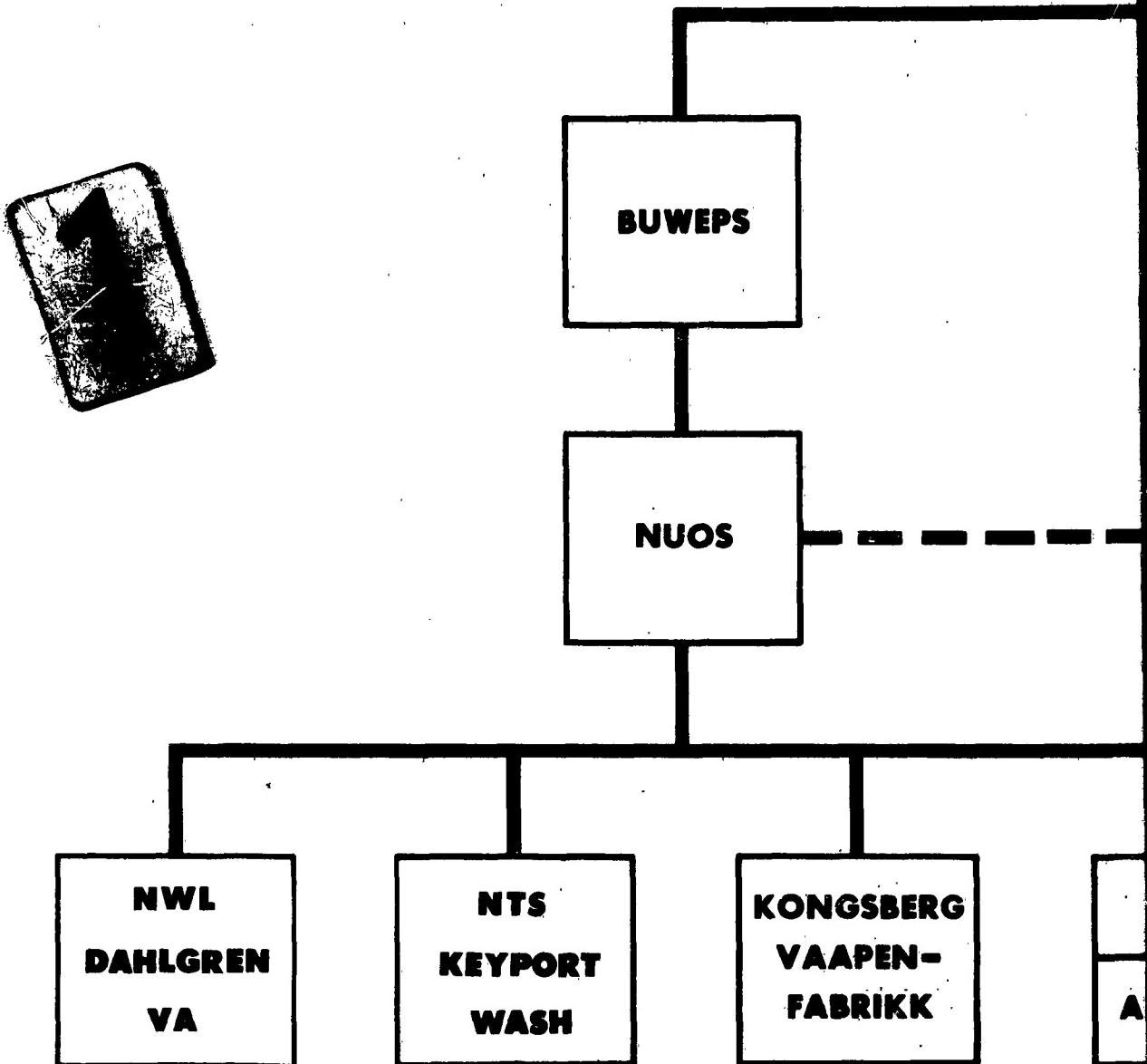
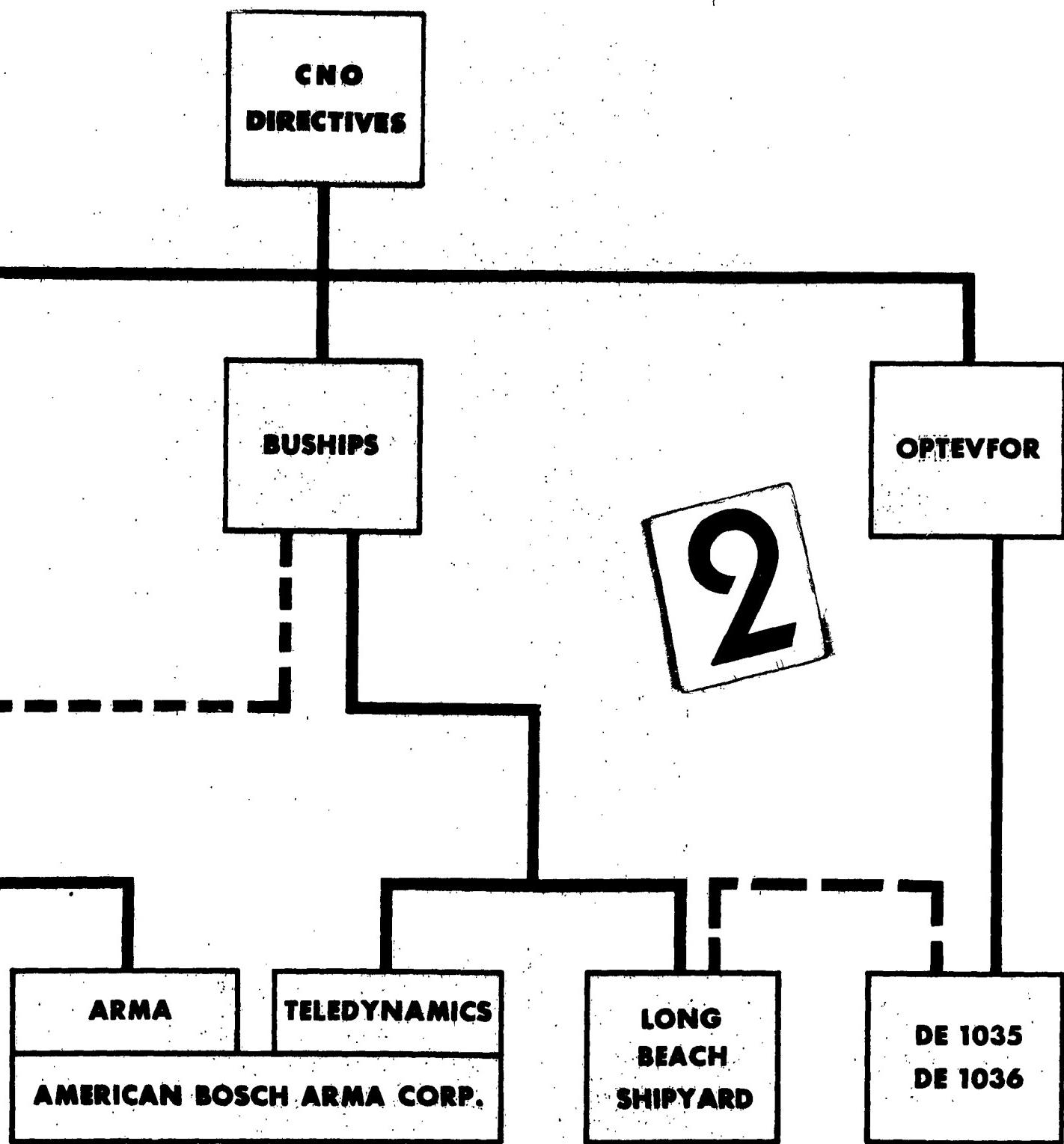


FIGURE 2.1 PARTICIPANTS



PARTICIPANTS IN U.S. TERNE III PROGRAM

The TERNE equipments were furnished by Kongsberg Vaapenfabrikk, Norway, under Contract NG 2558-2478. Work at KV was under the direction of Mr. B. Hurlen, the Technical Director; Captain Frihagen, Contracts; and Mr. K. Seim, Engineering. Under this contract, the Norwegians also provided technical assistance during the shipboard installation and evaluation.

Responsibility at Arma for technical assistance to NUOS for system integration, documentation, and for installation and evaluation support was under the cognizance of Mr. E.R. Behn, Section Head of Naval Projects. The Tele-Dynamics Division of the American Bosch Arma Corporation was responsible under BuShips Contract NObs 78906 for design and fabrication of two underwater battery switchboards for the integrated system.

2.3 CONTRACTUAL STATEMENT OF WORK

Contract N140(122) 69961B provided for the performance of such research, design, development and engineering services and for the manufacture and furnishing of such equipments and documentation required by the U.S. Navy Underwater Ordnance Station, Newport, Rhode Island, to install the Norwegian Terne III Weapon System on U.S. Navy Vessels DE 1035 and DE 1036; and integrating it with the existing weapon complement and Fire Control System MK 105 Mod 3.

The services and equipments to be furnished were to be in accordance with the U.S. Naval Underwater Ordnance Station Specification titled "Description and Requirements for U.S. Equipments and Services for Small Ship ASW Weapons System (TERNE) W-113", dated 1 February 1960 and Addendum I thereto; and Arma Division's Technical Proposal, Document A60-7 dated 29 February 1960, as amended by the formal contract.

The equipment and services to be furnished are itemized as in the contract, as follows:

Contract Item 1.*Signal Converter, quantity 2 eachTask:

Define requirements and engineer for service applications.

(Equipment designation became Electronic Frequency Converter MK 50 Mod 0)

Contract Item 2.*Fire Control SwitchboardTask:

Define requirements only.

(Equipment design and fabrication to be accomplished under BUSHIPS Contract NObs 78906 by Tele-Dynamics Division of the American Bosch Arma Corporation).

Contract Item 3.*Torpedo Presetter, quantity 2 eachTask:

Engineer for service application.

(Equipment designation became Control Panel MK 264 Mod 0)

Contract Item 4.*Ordalt Kits for Attack Director MK 5 Mod 3,
quantity 2 eachTask:

Define requirements and engineer for service application.

Contract Item 5.*New Design Equipment Documentation, quantity 1
set each. (End-Delivery: 300 printed copies)Task:

a. For Signal Converter

b. For Torpedo Presetter

*Phase I (See Para. 2.1)

Contract Item 6. **

Modified Equipment Documentation for Attack Director, quantity 1 set. (End-Delivery: 300 printed copies)

Task:

Preparation of Ordalts.

Contract Item 7. *

Norwegian Equipment Documentation, quantity 1 set, (End-Delivery: 300 printed copies)

Task:

Preparation of instruction books for the Norwegian manufactured equipments.

Contract Item 8. *

System Documentation, quantity 1 set. (End-Delivery: 300 printed copies)

Task:

Preparation of instruction books for the overall weapon system.

Contract Item 9. *Repair Parts

- a. Signal Converter, Item 1, quantity 2 sets.
- b. Torpedo Presetter, item 3, quantity 2 sets.

Task:

Furnish 2 sets each of repair parts for Signal Converter and Torpedo Presetter.

Contract Item 10.Engineering Services, as requiredTask:

Furnish services in the areas of:

- a. Liaison*
- b. Installation**
- c. Missile Component Evaluation*
- d. BUWEPS and OPTEVFOR Evaluation**
- e. Related Studies:**

Evaluate increased performance of U. S. Ordnance through use of Terne III Depth Sonar. Determine optimum vessel size for Terne III system.

* Phase I

** Phase II (See Para. 2.1)

2.4 CONTRACT MODIFICATIONS

During the term of Contract N140(122)69961B, there were 21 modifications. The modifications and related contract items are shown on the summary chart, figure 2-2. The effect of the modifications on the contractual statement of work is presented in the following tabulation.

<u>Contract Mod.</u>	<u>Date</u>	<u>Contract Items Affected</u>	<u>Description</u>
1	11/2/60	4; 6; 10a, b, d	Contract modified to provide for performance of Phase II in accordance with contract requirements, as if the option had been exercised. It also set forth that Clearance NY 10400.2, Serial 01017 of 6 June 1960 applied to the contract. (NUOS letter Del-T:TAL:cal-8510 Terne of 10 November 1960 clarified Security Check List, Form DD254, Item 19, Tests; as meaning the OPTEVFOR tests and not the equipment operating tests.)
2	11/9/60	10c	Limited Arma effort in the missile and fuze evaluation. This modification was later withdrawn by NPO Bklyn letter C-11:jw-N140(122)69961B of 16 December 1960, as result of a conference with NUOS on 22 November 1960, and NUOS letter Del-T:TAL;cal, 8510/Terne, 8 December 1960; which gave approval to an Arma document delineating the Arma efforts with regard to missile and fuze (laboratory) evaluation, and stated since this would clarify the contractual statement; contract modifications would not be required.
3	11/10/60	5	Added Arma interpretation of Military Specification MIL-D-70327, Drawings, Engineering and Associated Lists to the contract specifications (Arma Document 521-000-898).

<u>Contract Mod.</u>	<u>Date</u>	<u>Contract Items Affected</u>	<u>Description</u>
4	2/23/61	7	Revised titles of Terne Equipment Instruction Books and added a requirement to prepare documentation for the Terne III Power Panel (Power Distribution Panel MK 261 Mod 0). Also it noted that "Test Equipment for Terne Fuze" instruction book title would be determined after hardware availability.
5	3/28/61	10e	Directed Arma to perform a study of over-the-side torpedo launching requirements to: determine optimum launching doctrine for Torpedoes Mk 44 and 46; delineate the displays and/or computation required to utilize this doctrine; and prepare preliminary design specifications for modifications to existing surface ship fire control systems to implement the launching doctrine.
6	4/3/61	3, 7	Added a task to Define Requirements for the Torpedo Presetter. Also, added an Arma Engineering review of Terne Equipment Instruction Book manuscripts prior to final submission.
7	4/3/61	2, 8, 10	Provided for a study of the requirements for including the Torpedo MK 37 Mod 1, the installation of Torpedo Tube MK 25 and associated loading equipment, and modifications to FCS MK 105 for Terne III on DE 1035 and DE 1036, and also effect of Torpedo MK 37 Mod 1 on weapon system installed on DE 1033 and DE 1034. Amended Scope of Contract to add "The existing weapon system complement on U.S. Navy Vessels DE 1035 and DE 1036 shall include

<u>Contract Mod</u>	<u>Date</u>	<u>Contract Items Affected</u>	<u>Description</u>
7 (Cont'd.)			<p>Torpedo MK 37 Mod 1. Documentation required to be furnished under the terms of the contract shall provide for installation of the equipment required for this torpedo concurrently with the TERNE III weapon system installation.</p> <p>Note: Modification 7 was first amended by Modification 12, and then by Modification 15, to provide for clarification requested by Arma.</p>
8	4/3/61	4,6	<p>Added "Class 1" to Record Plans and LDs. Deleted requirements for modification of Attack Director Mk 5 Mod 3 and held in abeyance ORDALTS to Attack Director MK 5 Mod 5 pending further study. This amendment also changed cognizance of inspection and acceptance from BUWEPS RES REP ARMA TO INSMAT, Garden City.</p>
9	7/19/61	7,8,10	<p>Authorized Arma to revise system functional drawing, cabling diagrams, functional schematic drawings, and handbooks in accordance with drawings received from KV at conference in June 1961; KV ltr U/75, 2/61/TH/GA of 7 July 1961; and final revised drawings of AN/SQA-16 sonar transmitter/receiver and transformer box.</p>
10	8/17/61	4,10e	<p>Decreased funding under Phase I due to deletions of Modification No. 8, and increased funding under Phase II as a result of changes directed by Modification No. 5, resulting in a net increase of \$20,660 for the total estimated cost under the contract. Also added requirement for a short form ORDALT providing smoothed sonar range from Attack Director MK 5 to the Terne ASW System.</p>

<u>Contract Mod</u>	<u>Date</u>	<u>Contract Items Affected</u>	<u>Description</u>
11	8/17/61	All items	Time of Performance revised to that proposed by Arma ltr JFMcC-A453-C1122 of 28 February 1961 in lieu of original schedule submitted with the Technical Proposal (Arma Document A60-7). In addition, new completion dates were established for "time of performance" of the Related Studies task to allow for completion of related but more urgent work. It is to be noted that Modification 11 was concerned with the overall program schedule and contract "time of performance" and it is reflected in the program performance, Figure 4-1.
12	8/18/61	10b	This modification amended Modification 7 to delete the study report requirement for including a description of the technical modifications and problems relating to the physical installation of Torpedo Tube MK 25 and associated loading equipment.
13	9/1/61	10e	Gave technical direction to design, develop and manufacture two prototype Launch Range Display Units and 25 Simplified Torpedo Launch Range Slide Rules.
14	9/29/61	8, 10b	This modification directed that all references to depth charges be deleted from system documentation, as the existing weapon complement on DE 1035 and 1036 shall not include depth charges.
15	10/30/61	10b	This modification withdrew modification 12 in its entirety to restate the intent of Modification 7 and to define the GFM to be furnished.

<u>Contract Mod.</u>	<u>Date</u>	<u>Contract Items Affected</u>	<u>Description</u>
16	3/15/62	7, 10a, b	Decreased funding to correspond with complete deletion of remaining efforts for modification of attack directors. Also due to incompleteness of GFM, an increased effort in the areas of Norwegian equipment documentation, liaison, and installation was funded, resulting in an overall total estimated cost increase of \$44,779.
17	4/3/62	5, 10e	Deleted requirement for engineering study on application of Terne III missile to fleet type vessels. Also reduced requirements for quantity of torpedo presetter (Control Panel MK 264 Mod 0) instruction books from 300 to 20, resulting in a decrease in contract funding.
18	5/17/62	5	Provided for deletion of the requirement for authenticated drawings of Electronic Frequency Converter MK 50 Mod 0 under Phase I, Item 5. Also decreased contract funding and fixed fee.
19	8/29/62	5, 7	Provided for furnishing 6 copies each of preliminary instruction books of Norwegian equipments and Signal Converter for advance information and decreased the total number of books to be delivered as an end item from 300 to 250 copies (except for OP 3028 - 260 copies). (The reduction in quantity was equivalent to the cost of producing six copies, with no change in contract funding)

<u>Contract Mod.</u>	<u>Date</u>	<u>Contract Items Affected</u>	<u>Description</u>
20	12/14/62	5, 7, 8	<p>Clarified titles of instruction book deliverable end items and amended the Contract Schedule delivery dates for the remaining designated documentation as follows:</p> <p>NAVWEPS OP 3034 - Launcher, Loading House Equipment Vol. I, II. (Delivery prior to 1/4/63).</p> <p>NAVSHIPS 94181 - Sonar Depth Determining Group AN/SQA-16(XN-1) (Delivery prior to 1/4/63);</p> <p>NAVWEPS OD 15104 - ASW Weapon System Mk 1 Mod 0, Vols. I, II plus Addendum, III, IV. (Delivery prior to 3/8/63).</p> <p>Stated that requirement for instruction book for fuze test equipment (Item 7.i) was still pending.</p>
21	1/31/63	7	Corrected title for NAVSHIPS 94181 AN/SQA-16 (XN-1) Sonar Instruction Book as stated in Modification 20. Also established that delivery of Item 7.i would be as "Mutually agreed upon when work on Item 7.i is started."

Contract Items		Modifications																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Signal Converter															x					
2	FC SW BD								x							x					
3	Torpedo Presetter							x							x						
4	Ordalt Kits	x										x	x	x							
5	New Design Equip. Documentation		x									x						x	x	x	x
6.	Modified Equip. Documentation	x									x		x								
7.	Norwegian Equip. Documentation		x	x				x	x	x		x			x		x	x	x	x	x
8	System Documentation			x	x			x				x			x						x
9	Repair Parts											x									
10	Engineering Services	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

FIGURE 2-2 - SUMMARY CHART OF CONTRACT MODIFICATIONS

Section 3

TECHNICAL PERFORMANCE

This section summarizes the work accomplished under the contract, for each contract item. The summary also includes a statement of the scope of the task, and a review of the effect of pertinent contract modifications.

3.1 CONTRACT ITEM 1. SIGNAL CONVERTER

(Equipment nomenclature has been assigned as Electronic Frequency Converter Mk 50 Mod 0.)

SCOPE: Define Requirements and Engineer for Service Application.

This effort required the design, development and manufacture of two prototype frequency converters to permit data transmission between the Norwegian and U. S. equipments where these equipments were not compatible with regard to signal transmission.

1) Define Requirements Task

Under this task a design approval package, functional diagram and physical configuration layout consistent with available shipboard space, design and specification requirements were prepared, submitted, and approved by NUOS.

2) Engineer for Service Application Task

Under this task two prototype frequency converters were developed, fabricated and acceptance tested. These units were delivered to Long Beach Naval Shipyard and installed on DE 1035 and DE 1036 as part of ASW Weapon System Mk 1 Mod 0.

PERFORMANCE:

1) Design Configuration

The frequency converter design criteria were based on study of the functional requirements for the integration of Terne III, Item 10a. The following system functions required conversion:

<u>Symbol</u>	<u>Function</u>	<u>Signal Received</u>	<u>Signal Transmitted</u>
Hq	Target Depth	400 cycle scaled voltage @ 20mv/yd	60 cycle synchro signal @ 3,000 ft/rev Sonar depression angle 60 cycle synchro signal at 360°/rev (Eq)
Co	Own Course	60 cycle synchro signal @ 360°/rev	400 cycle synchro signal @ 360°/rev
Rq	Slant Range	60 cycle synchro signal at 72K and 2K yd/rev	400 cycle scaled voltage at 20 mv/yd (potentiometer) 400 cycle scaled voltage at 20 mv/yd 0.1% linearity (vernistat)
Swa	Apparent Wind Speed	60 cycle synchro signal at 100 kt/rev	400 cycle synchro signal at 100 kt/rev
Bwa	Apparent Wind Direction	60 cycle synchro signal at 360°/rev	400 cycle synchro signal at 360°/rev
cBrq	Generated Target Relative Bearing	60 cycle synchro signal at 360° and 10°/rev	400 cycle synchro resolver signal at 360°/rev
N	Pitch	60 cycle synchro signal at 180° and 10°/rev	400 cycle synchro signal at 120°/rev

<u>Symbol</u>	<u>Function</u>	<u>Signal Received</u>	<u>Signal Transmitted</u>
M	Roll	60 cycle synchro signal at 180° and 10°/rev	400 cycle synchro control and synchro torque signals at 120°/rev
A	Target Angle	60 cycle synchro signal at 360°/rev	400 cycle synchro signal at 360°/rev
So	Target Speed	60 cycle synchro signal at 100 kt/rev	400 cycle scaled voltage at 500 mv/kt

The converter is packaged in a reinforced sheetmetal drip proof cabinet enclosure. The cabinet contains ten servo assemblies, one for each of the functions to be converted; and a power supply. Each converter servo is a separate module. The power supply furnishes AC and DC operating voltages for the servo amplifiers. Heat dissipation is accomplished by a blower on the lower portion of the cabinet door and by ventilating louvres on both sides of the cabinet enclosure.

Two of the conversions have unique features; the target depth to depression angle conversion and the slant range conversion:

... Target Depth to Depression Angle. To stabilize bearing at the AN/SQS-31 sonar for roll and pitch to an accuracy which will not degrade system performance, the sonar stabilization computer (Computer Mk 108) must receive depression angle to an accuracy of $\pm 5^\circ$ for the Terne weapon ranges (1500 to 450 yards). To hold depression within this error (since a fixed depression angle will not satisfy accuracy requirements and depression is not attainable in the system otherwise), the depression angle (E_q) is approximated from depth information (H_q) by means of the empirically derived equation:

$$E_q = 5^\circ + .05 \text{ deg/yd} \times H_q \text{ (in yards)}$$

The above equation provides a good error distribution over all target depths from zero to 700 feet for Terne weapon ranges. At short ranges with deep targets the $\pm 5^\circ$ error limit may be exceeded but errors from this source will be overshadowed by system target prediction error.

The equation was instrumented by means of a gear train and a synchro position offset in the depth conversion servo.

... Slant Range. The Terne depth sonar computes horizontal range from target depth and an input of sonar slant range for use in the Terne weapon prediction solution. Therefore conversion of sonar slant range from a synchro order to a scalar quantity is required. The Attack Director Mk 5, however, has smoothed slant range output as a high speed (2,000 yds. per turn) signal only. The converter servo is instrumented to receive attack director computed horizontal range as a low speed (72 Kyds. per turn) signal although the high speed slant range and low speed horizontal range will not, in general, be synchronized. This is permissible since the purpose of the low speed signal is to keep the servo in its stops at ranges greater than 2,000 yards, otherwise the servo could synchronize to false readings. With reduction in gain, accomplished by an external transfer circuit which prevents the low speed signal from governing the servo unless the error signal represents more than 150 yards, the servo will synchronize to the high speed slant range signal with suitable accuracy and stability.

2) GFM Utilization. The converter unit design included Navy standard, Government-furnished amplifier and rotating components in accordance with Arma Proposal A60-7. The use of these standard parts served to reduce the number of new items to be added to Federal stock lists and also enabled the converters to be produced at minimum cost. The GFM utilized in the converter equipment is listed below for the two units:

<u>Description</u>	<u>Quantity</u>
Synchro - 15CT6a	22
Synchro - 15CX4b	12
Synchro - 15TR4C	2
Synchro - 15CX6XN	2
Synchro - 23TRX6a	4
Synchro - 23CX6a	2
Amplifier - 1625248	14
Amplifier - 1625247	2

Spare Parts (GFM) furnished U. S. Navy:

<u>Description</u>	<u>Quantity</u>
Amplifier - 1625248	4
Amplifier - 1625247	2

3) Related Documentation

The converter preliminary design approval package was submitted to NUOS for review by Arma letter JFMCC-A453-C5944 of 12 October 1960. On 9 December 1960, a preliminary design approval conference was held to review the comments contained in NUOS letter Del-T:TAL:akm-8510/TERNE of 1 December 1960. The agreements reached at this meeting were incorporated into the final design approval package which was submitted by Arma letter JFMCC-A453-C1094 of 27 February 1961. Final design approval was received by NUOS letter De2a-1:REB:jm-8200 of 20 March 1961. The Provisioning Parts List, submitted by Arma letter JEMCC-A453-C4549 of 4 August 1961, was approved by NUOS letter Del-T:LFR:akm-8510/TERNE of 20 September 1961. All other documentation including drawings was prepared and furnished in accordance with Contract Item 5, New Design Documentation. The instruction book title is NAVWEPS OP 3028, Electronic Frequency Converter MK 50 Mod 0; Description, Operation and Maintenance.

END ITEM DELIVERY: The first converter unit was delivered in July 1961, and the second unit in August 1961. Both units were shipped to Long Beach Naval Shipyard for shipboard installation; the first on DD250 - Partial Shipment No. 3, dated 13 July 1961, by GBL No. A-2998833 and the second on DD250 - Partial Shipment No. 4, dated 14 August 1963, by GBL No. A-2998969.

3.2 CONTRACT ITEM 2. FIRE CONTROL SWITCHBOARD

SCOPE: Define Requirements

Switching requirements were specified and shown on elementary wiring diagrams and a front panel layout. The two switchboards required for DE 1035 and DE 1036 were designed and manufactured under BUSHIPS Contract NObs 78906, by the Tele-Dynamics Division of the American Bosch Arma Corporation, Philadelphia, Pa.

CHANGE IN SCOPE:

In August 1960, OPNAV Instruction 0420.27B of 8 June 1960 (the Class Improvement Plan for DE 1033 class vessels) was received by NUOS. This instruction added the Torpedo MK 37 Mod 1 and associated fire control equipment to the ship weapon complement. NPO Brooklyn letter C-11:jw N140(122)69961B of 22 November 1960, directed Arma to generate information to provide for concurrent installation of Terne and Torpedo MK 37 Mod 1 systems. The addition of the provision for the installation of Torpedo MK 37 Mod 1 equipment resulted in the addition of a structural half section containing an accessory panel to the switchboard configuration. Contract Modification 7 of 3 April 1961 increased the funding under the contract to provide for the additional effort of adding the Torpedo MK 37 Mod 1 to the switchboard requirements.

PERFORMANCE:

Preliminary requirements and advance information were forwarded to NUOS and BUSHIPS for technical review via Arma letter, JFMCC-A453-C6362 on 31 October 1960. This information consisted of the following documentation:

... TERNE Fire Control Switchboard - Define Requirements task, Contract N140(122)69961B, Arma Document DG-E531-66

... Proposed Switchboard and Accessory Panel Layout, Arma Sketch DG-E531-65

... Guidance Diagram for UBFC Switchboard for DE 1035 - DE 1036, Arma Sketch DG-E531-32, (sheets 1 through 3).

NUOS letter De2a-1:GHA:akm-8510/TERNE of 22 December 1960 advised BUSHIPS (Code 635) that the documentation forwarded by Arma on 31 October 1960 was not adequate because of changes to the Class

Improvement Plans for DE 1033 class vessels, OPNAV INST 04720.27B. This letter also stated that NUOS was initiating a change to the Arma contract to allow for the inclusion of Torpedo MK 37 Mod 1 in the switchboard requirements, and it recommended that BUSHIPS authorize Tele-Dynamics to proceed with the fabrication of a basic switchboard which would provide space for the additional switching requirements. The letter established a date of 15 March 1961 for delivery of the final switchboard requirements to Tele-Dynamics.

During Tele-Dynamics and Arma conference on 26 January 1961, T-DD was advised as to the number of additional switchboard components (switches, lights, overload indicators, etc.) that would be required to accommodate the Torpedo MK 37 Mod 1 equipments. This was followed by a conference on 15 February 1961 to discuss switchboard layout and circuit requirements.

BUSHIPS letter DE 1035/9710, Ser. 665F-18, of 24 February 1961 advised NUOS that T-DD had been instructed to provide space in the DE 1035 and DE 1036 switchboards for Torpedo MK 37 Mod 1 requirements and requested that NUOS expedite the dissemination of the design data.

Arma letter JFMCC-A453-C1186 of 1 March 1961 forwarded preliminary copies of switchboard guidance drawings for ASW Weapon System MK 1 Mod 0, Arma document DG-E531-96 (sheets 1 through 4) to Tele-Dynamics. These plans provided for TERNE, Over-the-Side Torpedoes, and Torpedo MK 37 Mod 1 weapons equipment switching requirements.

On 13 and 14 March 1961, the switchboard guidance plans for DE 1035 and DE 1036, Arma document DG-E531-96 (sheets 1 through 4), and the proposed switchboard faceplate format, T-DD sketch 00057-304 were reviewed by BUSHIPS, Code 665f, at a meeting at BUSHIPS attended by representatives from BUWEPS, NUOS, T-DD, LBNS, and Arma. The drawings were approved subject to minor changes requested by BUSHIPS and the assignment of sonar lead designations.

On 21 March 1961, Arma visited BUSHIPS, Code 689c, to resolve assignment of sonar lead designations to be added to the switchboard guidance plans.

The final UBFC Switchboard requirements on Form DD 250 - Contract (Partial Shipment No. 1) were forwarded to NUOS, BUSHIPS (Codes 635 and 665) and Tele-Dynamics by Arma letter JFMCC-A453-C1806 of 27 March 1961. The plans included switching for control of equipment associated with the TERNE weapon, Over-the-Side Torpedoes MK 44 and MK 46, and Torpedo MK 37 Mod 1. Copies of these plans were hand delivered to LBNSYD on 28 March 1961 and to Tele-Dynamics on 24 March 1961. The plans consisted

of the following:

- ... Final Guidance Plans for ASW Weapon System MK 1 Mod 0 UBFC Switchboard, Elementary Wiring Diagram, Arma Document DG-E531-96, Rev. A
- ... Supplementary Switchboard Information, Arma Document DG-E531-101.

SWITCHBOARD FEATURES

The Final Guidance Plans and Supplementary Switchboard Information specified the design requirements for:

- ... Functional mode selective switching - OFF, TERNE TEST, TERNE, TORPEDO TUBE MK 25, TORPEDO TEST, and BOTH.
- ... Equipment action cut-out switching.
- ... Buss Testing (megger, frequency, and voltage).
- ... Fixed test signals in the TEST modes for system checks.
- ... Fusing and overload provisions.
- ... Indicator lamps.

Operational control of the integrated system is provided by a hand-operated Mode Selector switch via automatic JR-type switches and magnetic power contactors.

Action cut-out switching was provided for the Attack Director MK 5, Converter, MK 50 Control Panel MK 264 (torpedo presetter), Ships Course Indicator MK 6 Mod 5, Indicator Panel MK 263, Bearing Indicator MK 22, Computer MK 108 Mod 1, the sonar alarm circuits, the AN/SQS-31 (or 32) sonar and the sonar trainer, as well as the equipments for firing Torpedo MK 37 Mod 1. The Converter MK 50 action cut-out switching capability was functionally separated by assigning TERNE computer functions to one switch control and TERNE depth sonar to another switch. This permits cut-out of the computer functions of the converter while continuing availability of depth sonar functions from the converter.

Indicator lamps on the switchboard and on an associated Control Indicator Panel were provided to show availability of power and external synchro

signals, TERNE circuit breaker trip indication, sonar on target status, and System Mode Selector switch position.

Fusing of all power circuits originating within the switchboard was employed to insure protection against circuit shorting or overloading of ship-cabling. Fusing was also provided for all synchro excitation power originating external to the switchboard. Over-load indicators were used for only those synchro transmission circuits having a torque receiver as a load.

Switching was also provided for controlling the Power Distribution Panel MK 261 Mod 0 power contactors for Sonar Depth Determining Group AN/SQA-16(XN-1) and Analog Computer MK 142 Mod 0. Trip indication lamps were provided for the power panel circuit breakers. For personnel safety, the plans included a manually operated power interlock switch at the AN/SQA-16(XN-1) sonar which interrupts the control circuit for the power panel contactors when any maintenance is being done on the sonar and system power is on at the switchboard.

During the installation at LBNSYD, the following provisions were made for later installation of Torpedo MK 37 Mod 1 equipments:

... 115V 400 cycle (1X, 36X) Own Ship Course is cabled to the Switchboard and stubbed.

... 115V 400 cycle (2X) Roll is cabled to the Switchboard and stubbed.

... Own Ship Motion (MHOY and MHOX) is cabled to the switchboard and wired to the sonar trainer switch, then stubbed.

REVISIONS AND UPDATING OF THE FINAL SWITCHBOARD GUIDANCE PLANS

Revision B to the final guidance plans incorporated a change suggested by T-DD to eliminate the overloading of a JR switch and was forwarded to NUOS, BUSHIPS (Codes 635 and 665), and LBNSYD by Arma letter JFMCC-453-C1971 of 3 April 1961 and to T-DD by Arma letter JFMCC-A453-C1977 of 4 April 1961.

Changes to the final guidance plans, resulting from their review by NUOS, were generated during a NUOS visit to Arma on 12 April 1961. Revision C to the final guidance plans incorporated the NUOS comments and desired changes, as well as T-DD and Arma corrections, and was furnished to NUOS, BUSHIPS (Codes 635 and 665), LBNSYD, and Tele-Dynamics via Arma letter JFMCC-A453-C3720 of 19 June 1961.

During the installation and checkout of the ASW Weapon System MK 1 Mod 0 on the DE 1035, certain changes were required to be made to the UBFC Switchboard in order to insure the compatibility of the system. These changes were compiled and forwarded to Tele-Dynamics, NUOS, BUSHIPS (Code 665f) and LBNSYD as indicated below:

... Arma letter JFMcC-A453-C622 of 24 January 1962 forwarded Arma Document DG-E531-179, dated 23 January 1962, entitled: Report of modifications required to UBFC Switchboard as determined during the installation on the U.S.S. Charles Berry, DE 1035, at LBNSYD.

... Arma letter JFMcC-A453-C1436 of 1 March 1962 forwarded Arma Document DG-E531-194, dated 21 February 1962, entitled: UBFC Switchboard Changes required for compatibility of the switchboard with ASW Weapon System MK 1 Mod 0 requirements, in addition to information of 23 January 1962.

RELATED DOCUMENTATION

All other documentation for the switchboard was furnished to BUSHIPS by T-DD under Contract NObs 78906.

3.3 CONTRACT ITEM 3. TORPEDO PRESETTER

(Equipment nomenclature has been assigned as Control Panel MK 264 Mod 0.)

SCOPE: The objective of this task was to engineer a torpedo presetter for service application.

CHANGE IN SCOPE: The design, development and manufacture of two torpedo preseters was to be based on available specifications and data required for setting certain preset functions into Torpedoes MK 44 Mod 0 and 1, and MK 46 Mod 0. However, specific presetter specifications and design data were not available due to conceptual changes and changes in torpedo types and torpedo characteristics resulting from torpedo development at NOTS, Pasadena. The operational requirements for the torpedo presetter were initiated by CNO in 1959. NUOS letter to CNO, De264 GHA 8395 Ser. 0425 dated 30 June 1960 "Review of Preset and Computation Requirements for Torpedo Tube MK 32 Launching System" summarized the requirements as established to that date. The conceptual considerations and the final decision are indicated in the following table:

<u>Conceptual Consideration</u>	<u>Decision</u>
1. Portable (plug-in) vs. stationary	Stationary - mounted on Torpedo Tube MK 32
2. Indoor vs. outdoor use	Outdoor
3. Torpedo Tube status and torpedo type memory (torpedo signature circuits - remote displays)	Separate memory panel mounted indoors
4. Local firing key	Not required
5. Degree of enclosure	Water tight
6. Combined torpedo presetter and run-out computer	Presetter alone*

*The details of this decision are treated in section 3.10, Item 10e.

Each of the above conceptual considerations had substantial effect on the design of the torpedo preseters. The effort to define the presetter requirements was not included in the original scope of this task. This effort

was provided for by contract Modification 6, dated 3 April 1961.

PERFORMANCE:

1) Design Approval Package

A preliminary design approval package, providing for pre-setting Initial Search Depth (ISD), Search Floor and Gyro Angle, for Torpedoes MK 44 Mod 0 and 1, and MK 46 Mod 0 was submitted to NUOS on 15 July 1960, via Arma letter ERB-E531-C4239.

As a result of a meeting at NOTS, Pasadena on 10 August 1960, the preliminary design approval package was modified to include the additional presetting requirements for Torpedoes MK 44 Mods 2, 3 and 4. The revised preliminary design approval package was resubmitted to NUOS on 16 September 1960 by Arma letter ERB-E531-86. Approval of the design configuration and authorization to proceed was given in NUOS letter De 1-T:LFR:akm-8200 of 1 November 1960, based on agreements reached at a technical conference at NUOS on 22 September 1960. Additional changes resulted from a technical conference of 9 November 1960 and the final design approval package was submitted to NUOS by Arma letter ERB-E561-124 of 30 November 1960, and approved by NUOS letter De1-T1:TAL:akm-8510/TERNE of 16 January 1961.

2) Torpedo Presetter Description

The presetter (Control Panel MK 264 Mod 0) was designed for mounting either indoors (bulkhead mounting in UB Plot) or outdoors (on the Torpedo Tube MK 32). The illumination provided, therefore, had to meet both darkadaptation and outdoor intensity requirements.

The front cover display consists of an auxiliary plate and all functional switches and indicators. The unit contains a mechanical interlock which precludes setting ISD below Search Floor. The unit is gasketed and sealed to make a water tight package. The sandwich type construction of the cover incorporates a thermo-sheet heating element for de-icing of external controls and indicators.

The presetter is capable of presetting initial search depth, and search floor or gyro angle for torpedoes MK 44 Mods 0, 1, 2, 3, 4 and MK 46 Mod 0. Presetting is accomplished by a voltage bridge circuit, half of which is in the torpedo and half in the presetter. Bridge unbalance causes Ledex units in the torpedo to step in the direction to produce balance; unbalance is detected by an ultrasensitive current relay, a Barber Coleman Micropositioner.

The response of the torpedo is visually indicated by set lamps on the presetter. This is insured by circuits causing the torpedo Ledexes to step at least once on pressing the insert button, even though the torpedo has been previously set to the proper setting, and then seeking the designated position. These lamps will go out when the torpedo is fired or when any switch is disturbed.

A time delay circuit is included in the presetter in line with the fire signal which is initiated at the torpedo tube. The purpose of the time delay is to fire the gyro squib prior to energizing the solenoid valve at the tube, so that the gyro will have attained full speed and will be in control by the time the torpedo enters the water.

Circuit breakers are provided for both presetting power and firing power so that a momentary short will trip the breakers, which can be easily reset, and will not blow fuses in the UBFC switchboard.

Used in conjunction with the presetter is the mechanical memory unit, designated Control Panel MK 264 Mod 0 Memory Unit. It indicates current torpedo complement status and provides a ready reference chart for the various preset switch positions for each of the different torpedoes.

3) Related Documentation

The Parts Provisioning List was submitted by Arma letter JFMCC-A453-C2438 of 24 April 1961 and approval was indicated by telecon NUOS (Buben) to Arma (Romano) on 26 June 1961. Revisions reflecting changes during development were forwarded by Arma letter JFMCC-A453-C6409 of 25 October 1961. All other documentation including the instruction book was prepared and furnished under Item 5, New Design Documentation. The instruction book is identified as OP3029, Control Panel MK 264 Mod 0.

END ITEM DELIVERY: The two units, Control Panel MK 264 Mod 0 including Memory Unit, and two sets of repair parts, were shipped to NUOS on 21 June 1961 as DD250-Partial Shipment No. 2 under the subject contract.

3.4 CONTRACT ITEM 4. ORDALT KITS FOR ATTACK DIRECTOR MK 5 MOD 3

SCOPE: Define Requirements and Engineer for Service Application

The object of this task was to determine the feasibility of incorporating three modifications into the Attack Director MK 5 Mod 3 and to generate an ordalt for those that were feasible. The three modifications considered were:

- ... Automatic reception of target depth information.
- ... Utilization of range rate information in problem solution.
- ... Computation of aim point for the over-the-side torpedoes with runout (Torpedoes MK 44 and MK '46).

CHANGE IN SCOPE: As a result of Arma's investigation, recommendations were made in March 1961 to delete the addition of automatic depth input into the Attack Director. The Arma Study Report which summarized the investigation was forwarded to NUOS by Arma letter JFMCC-A453-C1693 dated 23 March 1961.

NUOS letter Del-T:TAL;akm 8200 of 22 September 1960 indicated that the Attack Director MK 5 Mod 5 would replace the Attack Director MK 5 Mod 3 on the Terne ships. The Attack Director MK 5 Mod 5 utilizes range rate information in its problem solution. Therefore, the effort to define requirements and engineer for service application the utilization of range rate information in the Attack Director MK 5 Mod 3 was no longer required.

NUOS letter De2b4:CHA:kay 8395 Ser. 0425 of 30 June 1960, indicated that modification of the Attack Director MK 5 Mod 3, to handle the over-the-side torpedo computation problem, is not readily possible.

Arma study report for Fire Control Requirements for Launching Over-the-Side Torpedoes (DR-E652-21) forwarded to NUOS via Arma letter JFMCC-A453-C6162 of 21 October 1960, concluded that doctrine firing of over-the-side torpedoes is feasible, that a computer is not justifiable, but that a mechanical aid to minimize decision making is recommended. This letter recommended a contractual change.

Contract Modification 8, dated 3 April 1961 made the following specific changes to the original effort:

- ... Changed the Attack Director MK 5 Mod 3 to be modified by the OrdAlts to Attack Director MK 5 Mod 5.

... Deleted the effort to define requirements for utilization of range rate information and engineer it for service applicability.

... Directed Arma to hold in abeyance the effort to define requirements for addition of automatic target depth and over the side torpedo computation pending completion of the feasibility studies.

Contract Modification 10, dated 17 August 1961, made the following specific changes to the original effort (NPO Brooklyn letters C-11:jw N140(122)69961B dated 2 February 1961 and C1-2:1d N140(122)69961B dated 7 July 1961):

... Deleted the effort to define requirements for the incorporation of automatic depth input and over-the-side torpedo computation (less the effort expended in the preparation of Arma report of Automatic Depth Input Study). Similarly the conclusions reached in Arma study Report for Fire Control Requirements for Launching Over-the-Side Torpedoes (DR-E652-21) led to the deletion of the effort to define the changes to the Attack Director MK 5 Mod 3 for the addition of aim point computation for over-the-side torpedoes. Arma's effort in preparing the report was completed prior to Amendment 10.

... Deleted the Engineer for Service Application effort for the incorporation of automatic depth input and over-the-side torpedo computation.

... Provided for the additional effort of preparing a Short Form OrdAlt to the Attack Director MK 5 Mod 3 to provide Computed Sonar Range (high speed only) as an output signal. The need for this functional requirement was established by Arma in performing the Terne system integration effort. At NUOS-Arma conference of 2/10/61, this requirement was presented and discussed and resulted in this contractual change.

PERFORMANCE (Effort Accomplished):

1) Preparation of Arma study report of Automatic Depth Input Study which was forwarded to NUOS via letter JFMcC-A453-C1693 dated 23 March 1961 (DD250-Partial Shipment No. 5 of 26 October 1961).

2) Preparation of Arma study report for Fire Control Requirements for Launching Over-the-Side Torpedoes which was forwarded to NUOS via letter JFMcC-A453-C6162 dated 21 October 1960. (DD250-Partial Shipment No. 5 of 26 October 1961.)

3) Preparation of Short Form OrdAlt to Attack Director MK 5 Mod 3 for computed sonar range (official NAVWEPS number never assigned).

It should be noted that an OrdAlt to the Attack Director MK 5 Mod 3 was also prepared under Contract Item 10e in connection with the Launch Range Display Unit installation.

3.5 CONTRACT ITEM 5. NEW DESIGN DOCUMENTATION

SCOPE: The purpose of this task was to furnish the following documentation for the signal converter (Contract Item 1), and the torpedo presetter (Contract Item 2):

<u>Documentation to be Supplied</u>	<u>Applicable Military Specifications</u>
Record Plans and Lists of Drawings	MIL-D-70327
Electron Tube and Semi Conductor Complement Report	Form DD 816
Bill of Materials	MIL-STD-295, NAVINST 3900.3
Military Specification	OSTD 67
Tentative Clarification of Defects	OSTD 78; OP 2161
Factory Acceptance Tests	NAVORD OD-10500
Provisioning Parts List	MIL-P-21078
Instruction Book in Preliminary Form	OP-1 (as a guide)
Non-Standard Parts List	MIL-F-18870A
Recommended Repair Parts	MIL-F-18870A

PERFORMANCE (Change in Scope): Tables 5-1 and 5-2 list all documentation prepared and furnished for the signal converter (Contract Item 1) and the torpedo presetter (Contract Item 3), respectively. The following information is supplementary to the tables and details changes in performance requirements.

1) Record Plans and List of Drawings.

A clarification of MIL-D-70327 was requested in October 1960 with respect to vendor drawings and existing drawings. This clarification was stated in Arma Document 521-000-898 and was approved by NUOS in their letter Del-T:TAL:dsr 8510/Terne of 21 October 1960. The requirement for authenticated drawings of both the signal converter and the torpedo presetter were deleted by contract modifications as follows:

a. Signal Converter. Record plans and drawing lists submitted 18 October 1961 by Arma letter JFMCC-A453-C6216 were held in abeyance by NUOS pending review. Subsequently it became apparent that further procurement

of the signal converter was not expected. Therefore authenticated originals and photo tracings were no longer required and the unauthenticated paper originals were considered acceptable (NUOS letter Del-T: LFR:akm-8510/Terne of 1 March 1962) as an end product. Arma letter JFMCC-A453-C2232 of 26 March 1962 requested that the requirement for authenticated drawings be deleted from the contract and also submitted information on the decrease in contract price resulting from the deletion. Modification 18, dated 17 May 1962, provided for deletion of the requirement.

b. Torpedo Presetter. The final design drawings were submitted to NUOS for approval by Arma letter JFMCC-A453-4913 of 22 August 1961. Subsequently, NUOS letter Del-T:LFR:akm-8510/Terne of 1 November 1961 indicated that unauthenticated paper originals were acceptable as deliverable end products. Arma letter JFMCC-A453-C7296 of 4 December 1961 requested that the requirement for authenticated drawings be deleted from the contract and furnished the information on the resulting decrease in contract price. Modification 16 provided for deletion of the requirement.

2) Instruction Books - Decrease in Quantity.

NUOS directed in their letter Del-T:LFR:akm-8510/TERNE-Ser. 0927 of 7 December 1961 that six copies of the signal converter OP 3028 instruction books be furnished for final review and approval in advance of scheduled deliveries of the end items. In discussions summarized in Arma letter JFMCC-A453-C2237 of 4 April 1962 to NUOS, it was indicated that the quantity of signal converter books to be delivered would therefore be reduced from 300 to 260, and requested contract modification. Modification 20 provided for this change without change in cost.

The torpedo presetter instruction book, OP 3029 Control Panel MK 264 Mod 0 was reduced in quantity from 300 to 20 by NUOS letter Del-T:LFR:akm-8510/TERNE - Ser. 0927 of 7 December 1961. This quantity was considered adequate to meet program requirements. Arma letter JFMCC-A453-C-2064 of 20 March 1962 advised NPO Brooklyn of the reduction in contract price resulting from the decreased effort and requested a contract change. This was also covered by contract Modification 20.

TABLE 5.1

DOCUMENTATION FOR SIGNAL CONVERTER (ELECTRONIC FREQUENCY CONVERTER MK 50 MOD 0)

Document	Submitted for Approval	Approved	End Item Delivery
<u>1. Record Plans and LD</u>			
Final design dwgs., ozalid copies (2) Unauthenticated paper originals and LD485786	18 October 1961	1 March 1962	4 June 1962 (DD250-Partial No. 14)
<u>2. Electron Tube Complement Report</u>			
Form DD 816 Revised to include development changes	8 March 1961 3 October 1961		
<u>3. Bill of Materials</u>			
This item part of Record Plan Assy. Dwg.s.			24 April 1962
<u>4. Military Specification, MIL-E-</u>			
Review and approval copies (2) Final copy (1), reproducible (1)	21 July 1961	11 August 1961	3 October 1961
<u>5. Tentative Classification of Defects, OCD 1356385</u>			
List of TCD's, correlation charts, assy. lists Original set (1), reproducible set (1), ozalids (7)	25 October 1961	1 March 1962	24 April 1962 (DD250-Partial No. 12)

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TABLE 5.1 (Continued)

Document	Submitted for Approval	Approved	End Item Delivery
<u>6. Factory Acceptance Tests, OD 15103</u>			
OD 15103 (2 copies), Allowable Error Calculations	2 May 1961		
Revised, development changes	16 June 1961	29 June 1961	
Filled in copies, reproducible Serials 1, 2; Ozalid copies to DE1035; DE1036 at LBNS			26 September 1961
Linear masters for authentication, INSMAT			26 October 1961
<u>7. Provisioning Parts List; PPL485786</u>			
Review and approval copies (2)	4 August 1961	20 September 1961	
Final recommended PPL and marked up LD485786			25 October 1961
<u>8. Instruction Book; OP3028 Preliminary, Electronic Frequency Converter MK 50 Mod 0*</u>			
Preliminary Draft	30 August 1961		
Final Draft (6 copies)	14 February 1962	10 April 1962	
Final copies (260)			29 May 1962 (DD250-Partial No. 13)

*Subcontracted Effort to Volt Technical Co., N.Y.C.

TABLE 5.1 (Continued)

Document	Submitted for Approval	Approved	End Item Delivery
9. Recommended Repair Parts List (2 copies)			
Included in Design Approval Package, Contract Item 1, resubmitted	27 February 1961	20 March 1961	20 March 1961
10. Non-Standard Parts List			
Included in Design Approval Package, Contract Item 1, resubmitted	27 February 1961	20 March 1961	20 March 1961

TABLE 5.2

DOCUMENTATION FOR TORPEDO PRESETTER (CONTROL PANEL MK 264 MOD 0)

Document	Submitted for Approval	Approved	End Item Delivery
1. Record Plans and LD			
Final design dwgs., ozalid copies (2)	22 August 1961	1 November 1961	22 November 1961 (DD250-Partial No. 6)
Unauthenticated paper originals and LD 485785			
2. Electron Tube Complement Report			
Form OD 816	8 March 1961	8 March 1961	
3. Bill of Materials			
This item part of Record Plan Assy. Dwgs.			22 November 1961
4. Military Specification, MIL-E-			
Review and approval copies (2)	28 April 1961	31 August 1961	31 August 1961
Revised, updated copies			
5. Tentative Classification of Defects, OCD 1356410			
List of TCD's, correlation charts, assy. lists, dwgs.	28 April 1961	28 April 1961	
Revisions, updated information	6 September 1961	16 January 1962	
Original set (1), reproducible set (1), ozalids (8), design analysis supporting data (1)			3 April 1962 (DD250-Partial No. 10)

TABLE 5.2 (Continued)

Document	Submitted for Approval	Approved	End Item Delivery
<u>6. Factory Acceptance Tests, OD15012</u>			
OD15012 (2 copies)	24 March 1961		
Revised development changes	17 April 1961	26 April 1961	
Filled in copies, reproducibles, serials 1, 2 ozalid copies to DE 1035, DE 1036	3 July 1961	31 August 1961	
Linen masters for authentication, INSMAT			26 September 1961
<u>7. Provisioning Parts Lists; PPL 485785</u>			
Review and approval copies (2)	24 April 1961		
Final recommended PPL and marked up LD		6 September 1961	
<u>8. Instruction Book; OP 3029 Preliminary Control Panel MK 264 Mod 0*</u>			
Preliminary Draft	18 July 1961		
Final Draft (6 copies)		12 March 1962	
Final copies (21)		*3 April 1962 (DD250-Partial No. 10)	

*Subcontracted effort to Volt Technical Co., N.Y.C.

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TABLE 5.2 (Continued)

Document	Submitted for Approval	Approved	End Item Delivery
<u>9. Recommended Repair Parts List</u>			
Included in Design Approval Package, Contract Item 3	30 November 1960	16 January 1961	8 June 1961
Revised to include development changes	8 June 1961		
<u>10. Non-Standard Parts List</u>			
Included in Design Approval Package Contract Item 3	30 November 1960	16 January 1961	8 June 1961
Revised to include development changes	8 June 1961		

3.6 CONTRACT ITEM 6. MODIFIED EQUIPMENT DOCUMENTATION
FOR ATTACK DIRECTOR, ITEM 4

SCOPE: The documentation to be furnished under this task was:

- ... OrdAlt Record Plans and Lists of Drawings
- ... Addenda Chapters to the OP for Attack Director MK 5 Mod 3
- ... OrdAlt Document

As previously discussed under Section 3.4 (Contract Item 4), the OrdAlt tasks to the Attack Director MK 5 Mod 3 as originally defined were deleted by contract Modifications 8 and 10 and consequently, related documentation was no longer required. Contract Modifications 8 and 10 deleted Item 6 in its entirety.

3.7 CONTRACT ITEM 7. NORWEGIAN EQUIPMENT DOCUMENTATION

SCOPE: The purpose of this task was to prepare and furnish 300 copies of preliminary instruction books for the Norwegian equipments that were to be furnished under a contract between Kongsberg Vaapenfabrikk, Norway (KV) and NUOS.

Accomplishment of this task was predicated on GFM consisting of Norwegian furnished drawings, lists, specifications, test data and procedures, and repair and maintenance procedures for the TERNE equipments.

The instruction books furnished were as follows:

NAVSHIPS 94181	Sonar Depth Determining Group AN/SQA-16 (XN-1), Vol. I and Vol. II - Drawings
NAVWEPS OP 3030	Analog Computer MK 142 Mod 0
NAVWEPS OP 3031	Position Indicator MK 99 Mod 0 and Indicator Panel MK 263 Mod 0
NAVWEPS OP 3032	Firing Panel MK 262 Mod 0
NAVWEPS OP 3033	Rocket Thrown Depth Charge MK 3 Mod 0
NAVWEPS OP 3034	Terne Launcher and Loading House Equipments, Vol. I and Vol. II - Drawings
NAVWEPS OP 3036	Dud Jettisoning Rocket MK 1 Mod 0
NAVWEPS OP 3037	Power Distribution Panel MK 261 Mod 0

The sonar books (NAVSHIPS 94181) were prepared using MIL specification 15017C as a guide. The draft manuscripts were furnished BUSHIPS for review, approval and assignment of a NAVSHIPS number and title by Arma letter JFMCC-A453-C4114 of 7 July 1961. Approval, designation and a distribution list contained in BUSHIPS letter N140(122)69961B-Item 7; Serial 242-912 of 24 August 1961, were transmitted to Arma by NPO Brooklyn letter C1-2:tj of 1 September 1961.

All the other instruction books were prepared based on using OP-1 as a guide. NUOS Standard 10 was subsequently used as applicable for

editorial standardization, in accordance with NUOS recommendations, at no additional cost. At NUOS request, these books were submitted for review as soon as prepared in order to facilitate their review at NUOS.

Approval of final drafts of these preliminary books was received over the period 27 June 1962 through 6 September 1962. All books were updated prior to final printing and delivery was made over the period 13 August 1962 to 10 January 1963.

CHANGE IN SCOPE:

1) Arma Engineering Reviews. In connection with the necessity to obtain engineering data at KV, in lieu of this information being GFM, engineering direction of the instruction book subcontractor (McLaughlin Research Corporation, N.Y.C.) was required. Though this direction was acknowledged as increased scope, at a conference at NUOS on 18 November 1960, it was considered that no additional funds would be required since provision had been made in the contract cost estimate for continuous Arma engineering services at KV on a resident basis for a ten month period. However, the data gathering effort at KV required additional engineering effort in the U.S. relative to assimilation of KV information and engineering reviews of draft manuscripts. Costs for this effort were furnished to NPO Brooklyn by Arma letters JFMcC-A453-C7217 of 8 December 1960 and JFMcC-A453-C7410 of 16 December 1960. Contract Modification 6 was issued to cover this increase in scope.

2) Addition of Instruction Book for Terne Power Panel (NAVWEPS OP 3037) Power Distribution Panel MK 261 Mod 0. The power panel became a part of the integrated system after the basic equipments to be furnished by KV had been determined. Thus it was not included in the original Item 7 list of equipments for which instruction books were to be furnished by Arma.

As a result of agreements reached 23 December 1960 (in telecon E. R. Behn, Arma, and T. Lemmis, NUOS), it was determined that an instruction book for the power panel was needed and it could be furnished without additional costs, though a contract change was required. This was based on the fact that subcontracting costs for the instruction books were below estimated costs and since the fuze test equipment was not forthcoming in the immediate future - a trade-off of substituting a power panel book for the fuze test equipment book was feasible because the equipments were estimated to be of comparable complexity.

A request was made by Arma letter JFMcC-A453-C263 of 16 January 1961 for an amendment to add the power panel to the list of instruction

books to be furnished. NUOS letter Del-T:LFR:akm-8510/TERNE of 14 February 1961 to NPO Brooklyn requested contract modification. Modification 4 was then issued to cover this change.

3) Incorporation of KV Drawing Changes. The original drawings of TERNE equipments furnished by KV were based on the TERNE system for the Norwegian destroyer Bergen and the development of the first of the two systems to be supplied the U. S. During production of the first and second systems, continual drawing changes were received. Arma letter JFMCC-A453-C4994 of 24 August 1961 stated the cost of additional efforts required for proper integration of these changes, and requested a contract modification to add the required funds. Contract Modification 9, dated 19 July 1961 was issued to cover the cost of incorporating all KV drawing changes. The Norwegian equipment draft manuscripts were updated accordingly and included all changes and final drawing information supplied by KV.

4) Decrease in Quantity of End Items. In the NUOS letter Del-T:LFR:akm 8510/TERNE; Ser. 0927 of 7 December 1961, Arma was directed to furnish six copies of each of the Norwegian equipment instruction books for final review and approval in advance of scheduled deliveries of the printed end items. Arma letter JFMCC-A453-C2237 of 4 April 1962 to NUOS indicated that the six advance copies could be provided and that the quantity of instruction books to be delivered would therefore be reduced from 300 to 250 to keep costs the same. Modification 20 provided for this change at no change in cost.

5) Deletion of Instruction Book for TERNE Fuze Test Equipment (Item 7.i). The preparation of this item was held in abeyance pending the receipt of GFM data for this instrument. Arma letter JA-A453-C8303 of 25 October 1962 stated that this item was open and awaiting the necessary information from NUOS or KV. Contract Modification 20 indicated that the "status for this document was still pending." Contract Modification 21 delineated the "delivery to be as mutually agreed upon when work on Item 7.i is started." NUOS letter Te3:FWK:dsr;8510/TERNE of 8 April 1963 deleted the requirement that the TERNE Fuze Test equipment instruction book (OP 3035) be supplied under the subject contract.

PERFORMANCE:

1) Data Gathering Effort at KV. At a meeting at KV in December 1959, it was indicated by KV that TERNE instruction books were to be furnished by KV for the Norwegian Navy. The information in these books were to be the basis for the U.S. instruction book effort, since the Norwegians had no experience with

U.S. publication specifications and approval procedures. At a second visit to KV (March 1960) it became apparent that Norwegian instruction books could not be made available in time. In July, 1960, at a third meeting at KV, tentative arrangements were made to gather the necessary technical data for preparation of the instruction books for the Terne U.S. equipments.

This was accomplished during the period 14 November to 18 December 1960. The effort involved frequent conferences with individual KV engineering personnel to determine equipment functional operation, and mechanical and electrical data. Drawings were obtained and reviewed and needed information and detailed data was requested. Documentary information such as test procedures, test data, and circuit alignment information was not available. Such information as well as troubleshooting data and repair and maintenance requirements and procedures were not obtained.

2) KV Engineering Review. Draft manuscripts prepared following the data gathering effort were furnished KV for engineering review and comment in March 1961. In April 1961, a conference was held at KV to review KV engineering comments and to obtain additional information. At this conference, the drafts were approved by KV as satisfactory and representative of the equipment. Both new and additional drawings were obtained at this time; however, the necessary repair and maintenance data was not available.

The drafts were further reviewed by KV personnel during system installation on the DE 1035 at Long Beach Naval Shipyard in August and December 1961. This review served to authenticate information added since the earlier data gathering and review at KV.

3) NUOS Review of Drafts. The preliminary draft manuscripts were furnished NUOS for approval for use during the TERNE Classroom Training Program of August 1961, at Long Beach Naval Shipyard. The submittal letter of 26 June 1961 (Arma letter JFMCC-A453-C3877) emphasized that the technical content of the instruction books was based on information received from KV, and did not include changes or test information resulting from checkout of the system on the Bergen. The general comment made by NUOS was in connection with the lack of repair and maintenance information in the book.

4) GFM supplied by KV. The information furnished by KV included the necessary electrical and mechanical assembly drawings to describe the equipment physically and functionally. However, the electrical drawings did not contain detailed information normally found on U. S. drawings. Though the specifications furnished were not complete for all equipments, they were used to determine parameters and system performance data. There were no "test" specifications, detailed in-line test procedures or data comparable to FATS

for reference furnished. As a result, the maintenance information contained in the end item preliminary instruction books could not be completed.

NUOS letter Del-T;LFR;akm-8510/TERNE-Serial 0927 of 7 December 1961 stated that KV intended to Provide GFM test and maintenance data, and that no action would be taken at that time on Arma letter JFMCC-A453-C5144 of 30 August 1961 outlining a proposal for generating this data. Complete GFM in this area was not furnished. Arma letter JFMCC-A453-C3550 of 1 May 1962, again called attention to the lack of needed government furnished test and maintenance data. Arma letter JFMCC-A453-C5373 of 2 July 1962 summarized the entire repair and maintenance data problem and recommended a planning conference at KV to determine means for generating the needed data as well as to resolve various system problem areas.

5) Additional Copies Made Available. Throughout the production of the Norwegian equipment instruction books, copies of interim drafts were furnished at NUOS request to:

Kongsberg Vaapenfabrikk, Norway	2 copies of each OP
Long Beach Naval Shipyard, California	1 copy of each OP
BUSHIPS	2 copies sonar NAVSHIPS 94181
BUWEPS	1 copy of each OP
OPTEVFOR	2 copies of each OP
DE 1035	1 copy of each OP
DE 1036	1 copy of each OP
Classroom and Shipboard Training	15 copies of each OP and NAVSHIPS 94181
NWL, Dahlgren	2 copies OP 3033 Rocket Thrown Depth Charge MK 3 Mod 0

6) Final NUOS Review. Six ozalid copies each of the instruction books were furnished NUOS for approval prior to printing final copies during the period 21 March 1962 - 7 June 1962. Comments and additional information requested were incorporated during the Arma final review task from June 1962 through November 1962.

7) Incorporation of Changes Due to Installation, Checkout, BUWEPS and OPTEVFOR Evaluations. The following information and changes were incorporated at no additional cost in the instruction books before they were finalized and printed for end item delivery.

- ... Added information resulting from ballistic changes to computer.
- ... Changes to revise computer problems in OP 3030 to provide more realistic values.
- ... Addition of a salvo problem, to the two single fire problems.
- ... Revised texts to incorporate change in salvo spread from 13.2 yds. to 20 yds.
- ... Added weatherhood description and operation.
- ... Revised description of Dud Jettisoning Unit.
- ... Revised launcher hoist hydraulic system descriptions.
- ... Revised transducer hoist description and illustrations.
- ... Updated sonar and computer air conditioning equipment descriptions and operation.
- ... Added launcher and loading house equipment and maintenance requirements.
- ... Added to line pattern potentiometer information.
- ... Revised description of Rocket Thrown Depth Charge MK 3 to incorporate fixes required by NWL tests of fuze.
- ... Revised fuze magazine information to incorporate type of magazine actually furnished by KV.
- ... Added fuze test and battery charger information to reflect use of shipboard fuze test set.
- ... Incorporated equipment wiring changes to reflect changes resulting from installation and checkout.

END ITEM DELIVERY. All Norwegian equipment OPs were delivered on DD 250 forms in accordance with contractual requirements, as listed below:

Item No.	Description	Quantity	Partial Ship- ment No.	Delivery Date
7a & 7b	NAVSHIPS 94181 Preliminary- Sonar Depth Determining Group AN/SQA-16 (XN-1), Volumes I and II	250 each	19	10 Jan. 1963
7c	NAVWEPS OP 3030 Prelim- inary - Analog Computer MK 142 Mod 0	250	17	23 Nov. 1962
7d	NAVWEPS OP 3031 Preliminary - Position Indicator MK 99 Mod 0 and Indicator Panel MK 263 Mod 0	250	16	13 Sept. 1962
7e	NAVWEPS OP 3032 Preliminary - Firing Panel MK 262 Mod 0	250	16	13 Sept. 1962
7f & 7g	NAVWEPS OP 3034 Preliminary - Terne Launcher and Loading House Equipment, Volumes I and II	250 each	19	10 Jan. 1963
7h	NAVWEPS OP 3033 Preliminary - Rocket-Thrown Depth Charge MK 3 Mod 0	246	18	15 Nov. 1962
7j	NAVWEPS OP 3036 Preliminary - Dud-Jettisoning Rocket MK 1 Mod 0	250	15	13 Aug. 1962
7k	NAVWEPS OP 3037 Preliminary - Power Distribution Panel MK 261 Mod 0	250	16	13 Sept. 1962

The repro material for the Norwegian equipment OPs was forwarded on DD 250 forms in accordance with contractual requirements, as listed below:

<u>Partial Shipment No.</u>	<u>Delivery Date</u>	<u>Repro Material Forwarded</u>
20	28 February 1963	NAVSHIPS 94181 NAVWEPS OP 3034
21	13 March 1963	NAVWEPS OP 3030 NAVWEPS OP 3031 NAVWEPS OP 3032 NAVWEPS OP 3033 NAVWEPS OP 3036 NAVWEPS OP 3037

3.8 ITEM 8. SYSTEM DOCUMENTATION

SCOPE: Under this task, as originally stated in the contract, Arma was to prepare a Weapon System instruction book (including description and operation, system checks, and system functional schematic diagrams) in three volumes. The deliverable end products were to be:

- (a) One (1) set of repro, consisting of one (1) set printer's negatives and artwork.
- (b) Three hundred (300) printed copies of the Weapon System instruction books.

The instruction book was to be prepared using OP-1 as a guide. The system checks in conjunction with the system functional schematic diagrams were to fulfill the following needs:

- ... Provide a basis for the initial complete system installation checkout.
- ... Provide a basis for determining overall system readiness during at sea operation prior to system use.
- ... Provide a basis of acceptability for equipment operation following repair during overhaul periods.

The scheduled delivery of the system instruction books was to be in accordance with schedule set forth in Arma Technical Proposal A60-7 of 29 February 1960. The dates given in A60-7 were:

- ... Draft copy - 1 May 1961
- ... Manuscript copy for approval - 10 October 1961
- ... 300 printed copies - 4 months after NUOS approval

INCREASE IN SCOPE

The original plans for the ASW Weapon System on the DE 1035 and DE 1036 called for the TERNE Weapon equipments to be integrated into the existing FCS MK 105 which when modernized would have the following weapon complement:

- ... Rocket Thrown Depth Charge MK 3 Mod 0
- ... Over-the-Side Torpedoes MK 43, MK 44, and MK 46
- ... Depth Charges MK 9 and MK 14

Shortly after the inception of the program in August 1960, OPNAV Instruction 0420.27B disseminated information to the effect that Torpedo MK 37 Mod 1 was to be installed aboard the TERNE vessels. A review was then made to determine the effects of installing Torpedo MK 37 Mod 1 on the DE 1033 class vessels. The results of this review were published as Arma Document A60-47, dated 20 September 1960. This report, together with budgetary prices for the increased contract effort that would be caused by adding the Torpedo MK 37 Mod 1 to the TERNE vessels, was hand delivered to NUOS in September 1960. The report contained a recommendation that the subject contract be modified to permit Arma to integrate the Torpedo MK 37 Mod 1 weapon requirements, as defined in OPNAV Instruction 0420.27B, into the weapon complement for the TERNE (DE 1035 and DE 1036) vessels.

NPO Brooklyn letter C-11:jw N140(122)69961B of 22 November 1960, directed Arma to proceed with the addition of the Torpedo MK 37 Mod 1 into the existing weapon complement on the TERNE vessels. Concurrently, as outlined in OPNAV Instruction 0420.27B, the Depth Charge Rack MK 9 was to be removed.

Subsequently, Contract Modification No. 7 of 3 April 1961 increased the funding under the contract to provide for the required documentation to be furnished under the terms of the contract to include the installation of Torpedo MK 37 Mod 1 equipment concurrent with the Terne Weapon system installation on the DE 1035 and DE 1036.

Contract Modification No. 12 of 18 August 1961 was issued to clarify the requirements of Modification No. 7, regarding Arma Document A60-47. Later, in response to Arma letter JFMCC-A453-05416 of 12 September 1961, Contract Modification No. 15 was issued on 30 October 1961 withdrawing Modification No. 12 and amending Modification No. 7 by redefining the requirements for Arma Document A60-47 and adding that certain GFM relating to the Torpedo MK 37 Mod 1 effort would be furnished.

On 28 February 1961, Arma letter JFMCC-A453-C1122 to NPO, Brooklyn (copy to NUOS) forwarded a revised Terne Program schedule which had been up-dated to allow for the additional effort required by the addition of Torpedo MK 37- Mod 1 to the Weapon System complement on the Terne vessels, with the request that the enclosed schedule, Arma Document CX 13, 352, be substituted for the schedule presently appearing in Arma Document A60-7 of 29 February 1960. This revised schedule changed the delivery dates of the Weapon System instruction book to read

...	Draft copy	- 1 October 1961
...	Final manuscript for approval	- 31 January 1962
...	300 Printed copies	- 4 months after NUOS approval.

Subsequently, Contract Modification No. 11 of 18 August 1961 revised time of performance under the contract to the schedule outlined in Arma Document CX 13, 352 in lieu of schedule outlined in Arma Document A60-7 of 27 February 1960.

Contract Modification No. 14 of 29 September 1961 confirmed the fact that the existing weapon complement on the DE 1035 and DE 1036 would not include depth charge armament, and it directed that no reference to this armament be made in the Weapon System documentation.

PERFORMANCE: The original planning for the Weapon System documentation required the production of a three-volume manual whose coverage was as follows:

- ... Volume 1 - System Description and Operation
- ... Volume 2 - System Check and Maintenance
- ... Volume 3 - System Check and Maintenance Log

The program for the preparation of the Weapon System Manual was initiated in December 1960. Under the program, some of the effort of originating the draft manuscript for Volume 1 was subcontracted to Washington Engineering Services Co., Inc., hereinafter referred to as WESCO. The effort of originating the draft manuscripts for Volumes 2 and 3 was to be done by Arma. Following the NUOS review, the effort of correcting the draft manuscripts to reflect the necessary changes would be done by Arma. The effort of typing the final manuscripts for all three volumes and the printing of 300 copies of each of the final manuscripts was subcontracted to WESCO.

When Arma was directed by NPO Brooklyn letter C-11:jw N140(122)69961B to include Torpedo MK 37 Mod 1 in the weapon complement on the Terne vessels, the Weapon System Manual was expanded to four volumes, as follows:

- ... Volume 1 - System Description and Operation
- ... Volume 2 - System General Data and Maintenance
- ... Volume 3 - System Readiness Checks
- ... Volume 4 - System Readiness Checks Log

The program for the preparation of the Weapon System manual was changed in January 1961 to provide for four volumes in lieu of three volumes. Under the revised program, WESCO was to assist Arma in originating the draft manuscripts for Volumes 1 and 2; while Arma was to prepare the draft manuscripts for Volumes 3 and 4. As before, WESCO was to type and print 300 copies of each of the final NUOS approved manuscripts. Arma was to supply all original art and the System Functional Schematic diagrams, see Contract Item 10b, for their use by WESCO in preparing the final manuscripts.

In April 1961, the System Readiness Checks test data for the Terne Computer MK 142 Mod 0, which had been developed by Arma, was checked by the IBM data computing facility at NUOS and found to be correct.

In May 1961, NUOS assigned NAVWEPS OD 15104 as the identification number for the ASW Weapon System MK 1 Mod 0 manual.

In August 1961, thirty (30) copies of Chapter 3 from Volume 1 were printed and bound by WESCO for use as a training aid during the school at LBNSYD, see Contract Item 10b. Chapter 3 presents a suggested system operating procedure as a guide to ship's personnel in developing their standard operating procedure for ASW Weapon System MK 1 Mod 0.

The draft manuscripts for Volumes 3 and 4 were completed in accordance with the requirements of the contract. The System Readiness Checks contained in these volumes served as the basis for acceptance of ASW Weapon System MK 1 Mod 0 during its installation and checkout on the DE 1035 and DE 1036 at LBNSYD, see Contract Item 10b.

Arma letter JFMCC-A453-C6454 of 27 October 1961 forwarded two (2) each preliminary draft manuscript copies for Volumes 3 and 4 of NAVWEPS OD 15104 to NUOS for review and comment. On 31 October 1961, four (4) copies of Volumes 3 and 4, respectively, were hand carried to LBNSYD where they were subsequently delivered to the DE 1035 and DE 1036, two copies to each ship.

Arma letter JFMCC-A453-C7985 of 28 December 1961 forwarded two (2) each preliminary draft manuscript copies for Volumes 1 and 2 of NAVWEPS OD 15104 to NUOS for review and comment. On 24 January 1962, four (4) copies of Volumes 1 and 2, respectively, were handcarried to LBNSYD where they were delivered to the DE 1035 and DE 1036, two copies to each ship.

NUOS letter Te2:MPS:dsr-5600/OD of 23 February 1962, granted approval to proceed with the preparation of the final manuscripts for Volumes 1 and 2 of NAVWEPS OD 15104. But this letter was subsequently followed by NUOS letter Te2C:FWK:leh-5600/OD of 8 April 1962, which requested that the preparation of the final manuscript for NAVWEPS OD 15104 be held in abeyance pending the analysis of results of the Bureau of Weapons Technical and Laboratory Evaluations.

NUOS letter Te2C:FWK:der-8510/TERNE of 6 March 1962, in reply to Arma letter JFMCC-A453-C278 of 2 February 1962 requesting information relative to the status of the NUOS review of Volumes 3 and 4 of NAVWEPS OD 15104, advised Arma that these volumes were currently being reviewed and checked during the installation and checkout of the fire control system on the DE 1036. The letter also stated that NUOS expected to complete their review by 2 April 1962.

Arma letter JLD-A453-C4407 of 31 May 1962 informed NUOS that all four volumes of NAVWEPS OD 15104 had been technically updated to include the results of the BUWEPS Technical Evaluation and also that the System Readiness Check test data for the Computer MK 142 Mod 0 had been modified to incorporate the hydroballistic trajectory curves for the Terne Rocket which had been forwarded by KV letter U/153/62/OW/Ga of 16 April 1962. The Arma letter also contained a request that the NUOS "hold in abeyance" order of 8 April 1962 be rescinded and that a directive be given to proceed with the preparation of the final manuscripts for Volumes 1, 2, 3 and 4.

NUOS letter Te2C:FWK:dsr-8510/TERNE of 6 July 1962, granted approval to proceed with the preparation of the final manuscripts for NAVWEPS OD 15104 provided that all information had been updated to include the BUWEPS OPTEVFOR Operational Evaluation.

At a conference at NUOS on 14 August 1962, Arma pointed out the need for a cutoff date relative to updating the information contained in NAVWEPS OD 15104. NUOS letter Te2C:FWK:dsr 8510/TERNE of 22 August 1962 directed that 27 August 1962 be the termination date for new material to be included in the final manuscripts for the Weapon System manual. This letter also directed that 20-yard spacing for Terne Salvo Firing be incorporated into the System Readiness Checks.

NUOS speedletter Te2C:FWK:dsr-8510/TERNE of 28 August 1962, in response to a telecon from Arma, authorized Arma to publish the System Functional Schematic diagrams under separate cover as an addendum to Volume 2 of NAVWEPS OD 15104.

Arma letter JA-A453-C8303 of 25 October 1962 to NUOS (copy to NPO, Brooklyn) requested that the schedule for delivery of the Weapon System instruction books, NAVWEPS OD 15104, Volumes I, II, II Supplement, III and IV, be changed to the first week in March 1963 by a modification in the contract. The letter pointed out that a change in the delivery schedule under the contract was required because of the many changes to be made in preparing the final manuscript and also due to the "hold in abeyance" request of 8 April 1962.

NUOS letter Te3-T:FWK:pe-4280 of 3 December 1962, requested NPO (Brooklyn) to issue a modification to the subject contract to reflect a scheduled delivery date of "prior to 8 March 1963" for NAVWEPS OD 15104, Volumes I, II plus addenda, III and IV. Subsequently, Contract Modification No. 20 of 14 December 1962 revised the deliverable end products for the Weapon System manual (Item 8) to read "300 copies of NAVWEPS OD 15104, ASW

Weapon System MK 1 Mod 0, Volumes I, II plus addendum, III and IV "in lieu of" 300 copies of Weapon System W-113 Manual (including Description and Operation, System Checks, and System Functional Schematics - 3 volumes)." The scheduled date of delivery for Item 8 was amended to read "prior to 8 March 1963."

NAVWEPS OD 15104 was delivered in accordance with the terms of the contract in March 1963. The system manual, as published, has the following coverage:

... Volume 1, ASW Weapon System MK 1 Mod 0, Description and operation - contains a general description of system; a functional description including the fire control geometry for each weapon; and system operating instructions for each shipboard station arranged in tabular form as incident-action-events in chronological sequence.

... Volume 2, ASW Weapon System MK 1 Mod 0, General Data and Maintenance - contains synchro loading diagrams for the system; an equipment data summary which provides a brief description of the physical and functional characteristics of each equipment in the system including signal inputs and outputs and power requirements; system general maintenance procedures and philosophy; and service hints which provide general repair information for ready reference.

... Volume 2 Supplement, ASW Weapon System MK 1 Mod 0, General Data and Maintenance, System Diagrams - contains seventeen system functional schematic diagrams depicting the system wiring for signal and power flow.

... Volume 3, ASW Weapon System MK 1 Mod 0, System Readiness Checks - contains overall weapon system checks designed to determine whether the functional operation of each of the fire control equipments is in accordance with prescribed requirements. This volume also contains weapon firing circuit and command checks, system alignment checks, and individual equipment checks for isolating sources of trouble.

... Volume 4, ASW Weapon System MK 1 Mod 0, System Readiness Checks Log - contains a supply of log sheets in the form of check-off lists or problem record sheets for recording the results of the tests prescribed in Volume 3.

END ITEM DELIVERY

The volumes of NAVWEPS OD 15104 were delivered on DD 250 forms in accordance with the terms of the contract, as listed below:

<u>Volume No.</u>	<u>Description</u>	<u>Quantity</u>	<u>Partial Shipment No.</u>	<u>Delivery Date</u>
1	ASW Weapon System MK 1 Mod 0- Description and Operation	300	23	29 Mar. 1963
2	ASW Weapon System MK 1 Mod 0- General Data and Maintenance	300	24	29 Mar. 1963
2 Supple- ment	ASW Weapon System MK 1 Mod 0- General Data and Maintenance, Systems Diagrams	300	25	29 Mar. 1963
3	ASW Weapon System MK 1 Mod 0- System Readiness Checks	300	22	18 Mar. 1963
4	ASW Weapon System MK 1 Mod 0- System Readiness Checks Log	300	26	22 Mar. 1963

The reproducible copy and negatives for NAVWEPS OD 15104 (all volumes) were delivered on DD250 as Partial Shipment No. 27, dated 29 May 1963.

3.9 CONTRACT ITEM 9. REPAIR PARTS

SCOPE: Furnish two sets of repair parts for signal converter and torpedo presetter in accordance with MIL-F-18870A.

PERFORMANCE: Two sets of repair parts for the new design equipments, signal converter and presetter, were furnished for DE 1035 and DE 1036. These parts were furnished in accordance with lists approved by NUOS, as outlined below, and they were intended to provide maintenance support over a period of one year.

- ... Converter list approved by NUOS letter De2a-1:REB:jm 8200 of 20 March 1961.
- ... Presetter list approved by NUOS letter Del-T1:TAL:akm 8510/TERNE of 16 January 1961.

END ITEM DELIVERY

1) Signal Converter (Electronic Frequency Converter MK 50 Mod 0). Two sets of repair parts were delivered: One set on DD 250 - Partial Shipment No. 4 of 14 August 1961 and the other set on DD 250 - Partial Shipment No. 3 of 13 July 1961, to Long Beach Naval Shipyard, Long Beach, California.

2) Torpedo Presetter. Two sets of repair parts for the Control Panel MK 264 Mod 0 were furnished on DD 250 - Partial Shipment No. 2 of 7 June 1961 to Receiving Officer, U. S. Naval Underwater Ordnance Station, Newport, Rhode Island, Attention Del-T.

3.10 CONTRACT ITEM 10. ENGINEERING SERVICES

Under Item 10 of the contract, Arma was to furnish engineering services as required for:

- a. Liaison
- b. Installation
- c. Missile Component Evaluation
- d. BUWEPS and OPTEVFOR Evaluation
- e. Related Studies to
 - (i) Evaluate increased performance of U. S. Ordnance through use of TERNE III Depth Sonar.
 - (ii) Determine optimum vessel types for TERNE III systems.

The performance and work accomplished under these tasks is reviewed in the following subsections.

3.10.1 CONTRACT ITEM 10a: LIAISON

Scope: This task provided for furnishing engineering services in the form of technical liaison with Norwegian and U. S. Naval activities. The objective of this task was to eliminate program interface problems existing between the Norwegian and U. S. equipments and the shipboard installation. The program geography is shown on the diagram, figure 3-1.

The need for this task arose because there could not be a system test of the KV equipment prior to shipboard installation. In view of schedule requirements and ship availability, the liaison effort was to include:

- ... Surveillance of Norwegian and U. S. equipment manufacturing activities.
- ... Gathering technical data for preparation of system drawings (including preparation of functional schematics) and system and equipment instruction books.
- ... Review of Norwegian prepared documentation.
- ... Witnessing of Norwegian final equipment acceptance tests.

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LEGEND

DAHLGREN, VA. - NAVAL WEAPONS LABORATORY
GARDEN CITY, N.Y. - ARMA DIVISION
KEYPORT, WASH. - NAVAL TORPEDO STATION
KEY WEST, FLA. - KWESTEVDET
LONDON, ENGLAND - NAVAL PROCUREMENT OFFICE
LONG BEACH, CALIF. - LONG BEACH NAVAL SHIPYARD
NEW LONDON, CONN. - USNUSL
NEWPORT, R. I. - NAVAL UNDERWATER ORD. STA.
WASHINGTON, D.C. - BUWEPS, BUSHIPS, BUPERS
HORTEN, NORWAY - NORWEGIAN DEFENSE RESEARCH ESTABLISHMENT
KONGSBERG, NORWAY - KONGSBERG VAAPENFABRIKK
OSLO, NORWAY - MILITARY ALLIED ASSISTANCE GROUP - NDRE
SAN DIEGO, CALIF. - NAVAL OPERATING BASE
PHILADELPHIA, PA. - TELE-DYNAMICS DIVISION - ABAC

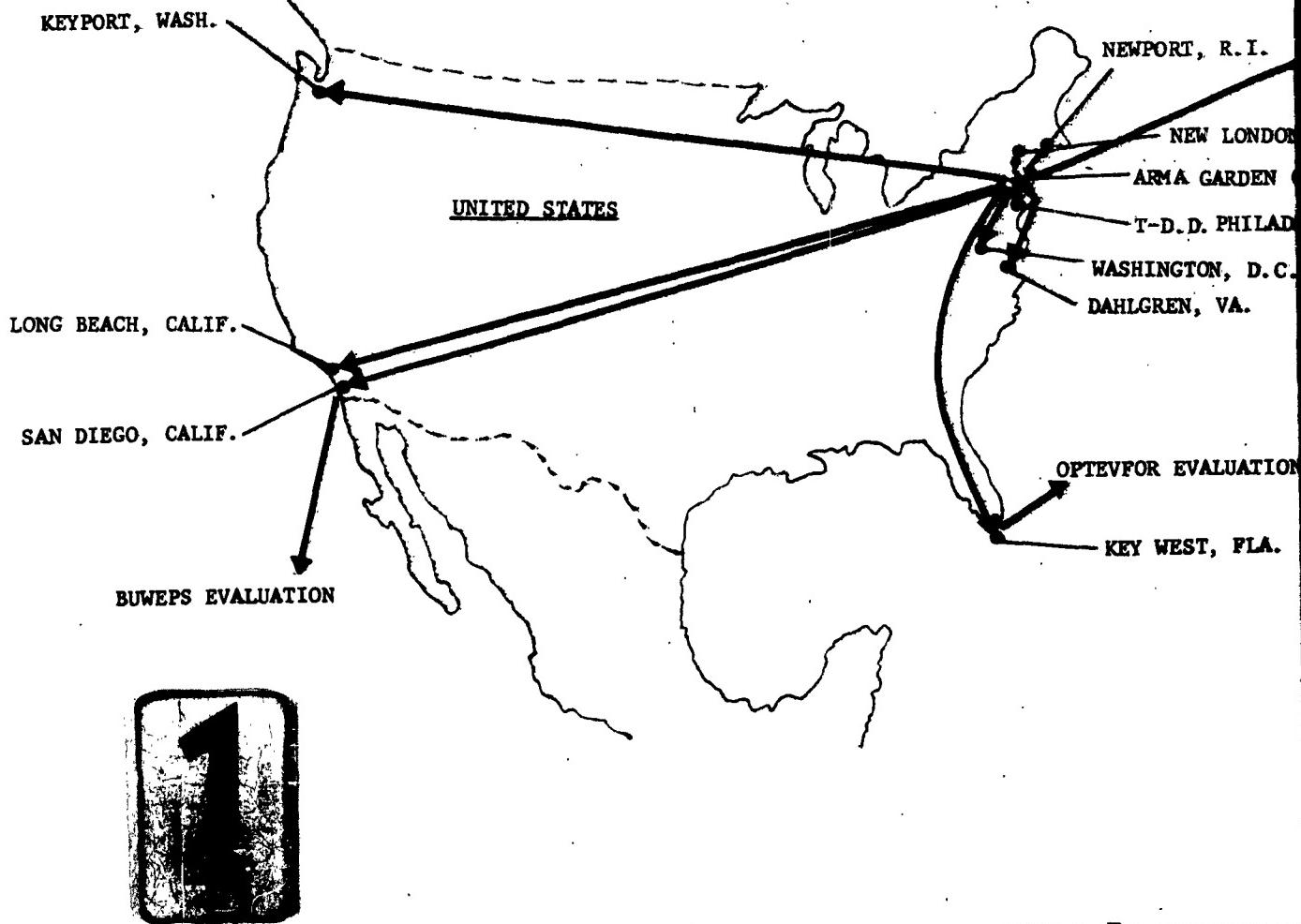


FIGURE 3-1 PROGRAM GEO

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NEWPORT, R.I.

NEW LONDON, CONN.

ARMA GARDEN CITY, N.Y.

T-D.D. PHILADELPHIA, PA.

WASHINGTON, D.C.

DAHLGREN, VA.

OPTEVFOR EVALUATION

KEY WEST, FLA.

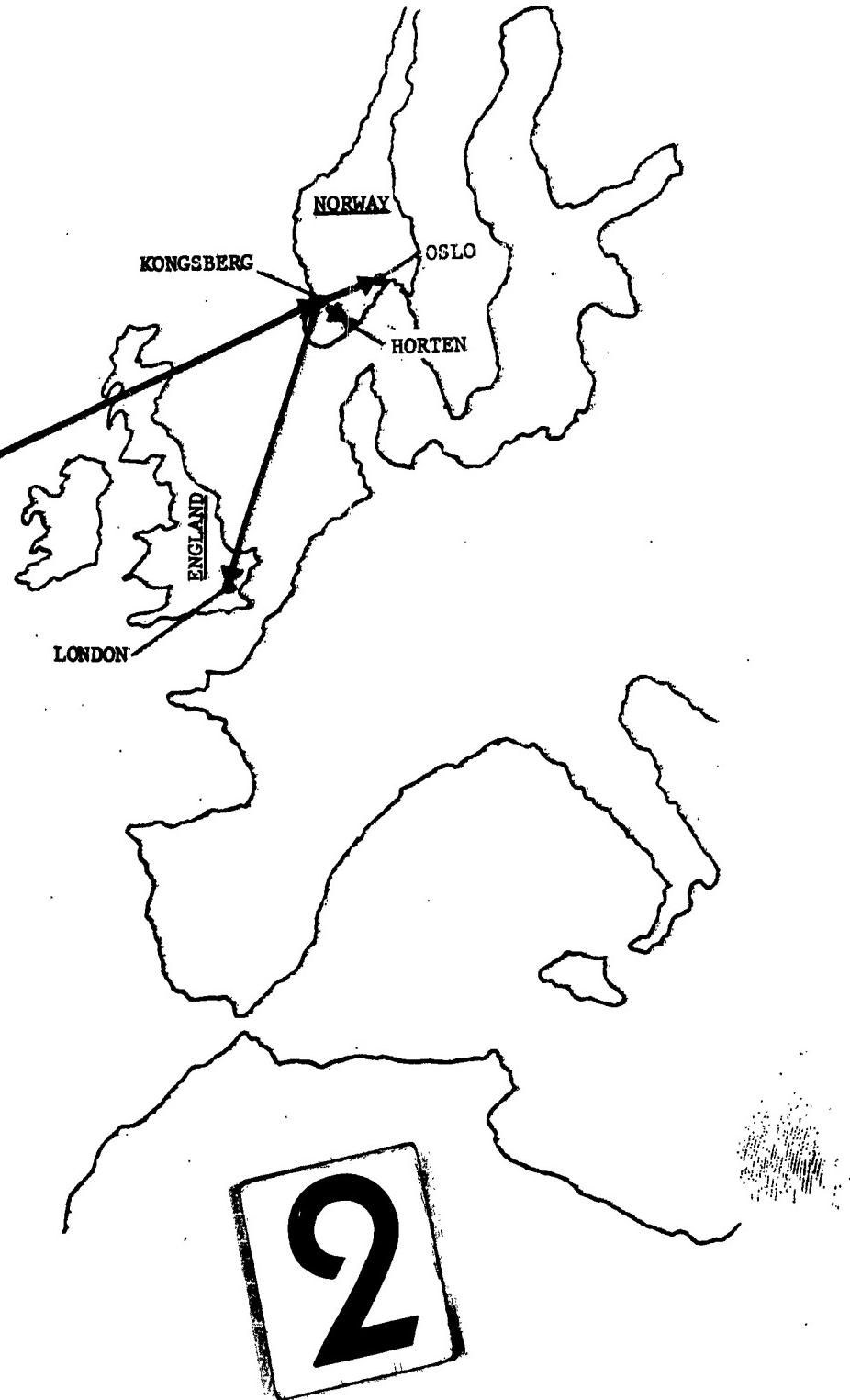


FIGURE 3-1 PROGRAM GEOGRAPHY

CONFIDENTIAL

... Installation planning with KV, NDRE, BUWEPS, BUSHIPS and LBNSYD.

... Planning for BUWEPS technical evaluation of the system as installed on DE 1035.

Performance: The liaison objectives were accomplished through conferences. These were held to establish program progress, resolve interface problems, and to obtain any available maintenance and installation data. The conferences are listed in Appendix A.

The activities conferred with most frequently, other than NUOS, were KV and Long Beach Naval Shipyard. The principal meetings at KV are listed for information purposes but only the first meeting is summarized, since the results of this meeting set up the patterns for interchange of information and established the basis for technical liaison. To plan for the first U. S. Meeting at KV, a conference was held by BUWEPS in Washington on 10 December 1959. This conference established an agenda for the KV meeting covering system principles, hardware procurement, documentation, services, liaison and contractual requirements.

Conference at KV, 14 - 18 December 1959

Purpose: 1. To determine the TERNE equipment to be supplied by KV and their delivery schedule in order to provide the basis for a KV-NUOS contract.

2. To prepare a progress plan providing for the necessary technical liaison for the design, manufacture and installation of the system on two U. S. destroyers.

Participants: Representatives from

U. S. Naval Underwater Ordnance Station
BUWEPS
BUSHIPS
Military Allied Assistance Group (MAAG)
U. S. Office of Naval Research (ONR) London, England
Arma Division, American Bosch Arma Corporation
Royal Norwegian Navy (RNN)
Norwegian Defense Research Establishment (NDRE)
Kongsberg Vaapenfabrikk (KV)

Conclusions: The following agreements were reached:

1. The Terne Computer became part of the basic weapon system.
2. The components to be supplied by KV were determined.
3. Quantities of missiles and missile components including warheads and deliveries for BUWEPS evaluation were established.
4. Arrangements were made for KV to supply repair parts lists, drawings and related specifications and instruction manuals (prepared for the Norwegian Navy.)
5. Packaging and inspection details.
6. Equipment to be procured against NDRE specifications for terne system and major components.
7. Established requirements and schedules to meet U. S. installation requirements.
8. Launcher Weapon system blast protection, firing angle limitations, interlock and safety precautions were established.
9. Sonar requirements were established.
10. Power Requirements were reviewed.
11. Arrangements were made for interchange of information for a missile and fuze evaluation program.
12. KV to provide engineering services during design, manufacture, installation and "initial training".
13. Basic contract requirements for procurement of the Norwegian equipments and services.

Subsequent Meetings at KV. The following meetings were held at KV during the term of this contract.

- 23 March, 1960 Arma, NUOS, KV, NDRE
To exchange technical information between KV, Arma and U. S. concerning technical interface problems relating to the installation of the integrated system in two U.S. ships.
- 11-28 July, 1960 Arma, NUOS, BUSHIPS, BUWEPS, KV, NDRE
To review functional diagram of system, determine system cabling and power distribution requirements, determine sonar requirements, logistic support, missile data, and drawing and instruction book documentation.
- 3 October, 1960 Arma, NUOS, KV, NDRE
To review schedule progress, weatherhood design, establish repair parts and review problem areas.
- 14-18 Nov. 1960 Arma, KV, NDRE
To commence instruction book preparation by Arma at KV; to obtain weatherhood data and discuss progress.
- 13-15 Dec. 1960 Arma, NUOS, KV
To review instruction book effort, obtain installation data for weatherhood, review repair parts and delivery status of missile components, single rail launcher and air conditioning equipment.
- 21 February -
2 March, 1961 Arma, NUOS, KV
To review sonar hoist and transducer installation details, final KV drawings, launcher and weatherhood installation.

4 April -
17 April, 1961

Arma, KV

To review instruction book drafts and installation data with KV, installation requirements and engineering services required during training and installation at Long Beach Naval Shipyard.

31 May -
9 June 1961

Arma, NUOS, KV

To review production and acceptance test status, delivery schedule, shipping and packaging, final documentation and installation details.

Technical Conferences at Long Beach Naval Shipyard. Information obtained from KV or generated at Arma was transmitted for installation purposes to LBNSYD in a series of conferences beginning in April 1960. These conferences are discussed in connection with the Installation Task, section 3.10b.

Norwegian Documentation Review. Under the Liaison task, a review was made of all documentation furnished by KV to assure compliance with the documentation requirements of the KV-NUOS contract. This effort was needed because of differences in drawing practices and types of drawings. The requirements for this documentation are set forth in the NUOS-KV contract and are summarized in Appendix II of Arma Document A60-7, in order to define the area of effort.

Documentation in the form of drawings and limited specifications were delivered by KV to Arma at the conferences and by mail. This information was reviewed, utilized in preparation of switchboard guidance plans and functional schematics and copies sent to NUOS and to the instruction book subcontractors.

The results of the review are shown in Arma Document DG-E531-187 "Review of Final Documentation, Terne III Equipment", and is Appendix B of this report.

Preparation of Recommended Factory Acceptance Tests.

In connection with providing technical assistance to NUOS, a set of recommended FATS for all equipment being supplied by KV were prepared. These FATS outlined the minimum acceptance requirements to

- ... Assure satisfactory equipment operation
- ... Assure uniformity of all equipments in each system
- ... Assure satisfactory integration into FCS Mk 105
- ... Assure satisfactory system operation with minimum shipboard check-out effort.

The information for these FATS was based on the March 1961 drawings and information received from KV. The FATS were specifically prepared as a guide to the Norwegians in preparing their own acceptance tests. The intent was to minimize shipboard problems.

3.10.2 ITEM 10b: INSTALLATION

Scope: Under this task, engineering support to NUOS was provided by Arma in four areas of effort, as follows:

- ... System Integration and Analysis
- ... Preparation of System Functional Schematic Diagrams
- ... System Installation and Checkout
- ... Training

The original contract provided for the engineering assistance required to carry out the above efforts for installing the Terne Weapon equipment into a FCS Mk 105 which when modernized would have the following weapon complement:

- ... Rocket Thrown Depth Charge Mk 3 Mod 0
- ... Over-the-Side Torpedoes Mk 43, Mk 44, and Mk 46
- ... Depth Charges Mk 9 and Mk 14

Change in Scope:

Shortly after the inception of the program in August 1960, OPNAV Instruction 0420.27B disseminated information to the effect that Torpedo Mk 37-1 was to be installed aboard the Terne vessels. A review was then made to determine the effects of installing Torpedo Mk 37-1 on the DE 1033 class vessels. The results of this review were published as Arma Document A60-47, dated 20 September 1960. This report outlined the additional switchboard and power requirements for DE 1033 and DE 1034 (without Terne) and for DE 1035 and DE 1036 (including Terne) resulting from the installation of the Torpedo Mk 37-1 weapon. Three copies of this report, together with budgetary prices for increased contract effort that would be caused by adding the Torpedo Mk 37-1 to the Terne vessels, were hand-delivered to NUOS in September 1960. The report contained the following recommendations:

- ... That a FRAM II switchboard be considered for installation aboard the DE 1033 and DE 1034.
- ... That the subject contract be modified to provide Arma services to integrate the Torpedo Mk 37-1 weapon requirements, as defined in OPNAV Instruction 0420.27B, into the weapon complement for the Terne (DE 1035 and DE 1036) vessels.

NPO Bklyn letter C-11:jw N140(122)69961B of 22 November 1960 directed Arma to proceed with the addition of the Torpedo Mk 37-1 into the existing weapon complement on the Terne vessels. Concurrently, as outlined in OPNAV Instruction 0420.27B, the Depth Charge Rack Mk 9 was to be removed.

Contract Modification No. 7 of 3 April 1961 increased the funding under the contract to provide for the required documentation showing the installation of Torpedo Mk 37-1 equipment concurrent with the Terne Weapon system installation on the DE 1035 and DE 1036. The modification also directed that Arma conduct a study of the requirements for including the Torpedo Mk 37-1. One of the requirements delineated in Modification No. 7 was that the report should include a description of the requirements for making the physical installation of the Torpedo Tube Mk 25 and associated Loading Equipment. Since the LBNSYD had been directed by BUSHIPS to make a ShipAlt analysis to cover the physical installation, Arma suggested that this requirement be deleted from Modification No. 7. Attention was also directed to the fact that Arma document A60-47 satisfied the study report requirements with this one exception.

Contract Modification No. 12 of 18 August 1961 was issued to clarify the requirements of Modification No. 7, regarding the study report requirements. Later, in response to Arma letter JFMCC-A453-05416 of 12 September 1961, Contract Modification No. 15 was issued on 30 October 1961 withdrawing modification No. 12 and amending Modification No. 7 as to the scope of the study effort. Modification No. 7, as clarified by Modification No. 15, provided for:

- ... A study report covering system requirements relative to installation of Torpedo Mk 37-1 and recommendations in connection with these requirements. The report was not to cover technical installation problems relating to individual equipments.
- ... Increased scope in the areas of "System Integration and Analysis" and the "Preparation of Functional Schematic Diagrams" for incorporating Torpedo Mk 37-1 capability into ASW Weapon System Mk 1 Mod 0.

Contract Modification No. 14 of 29 September 1961 specified that "the existing weapon complement on U. S. Navy Vessels DE 1035 and DE 1036 shall not include depth charge armament". The ASW weapon complement for the DE 1035 and DE 1036 was to consist of:

- ... Torpedo Mk 37-1 (U. S.)
- ... Over-the-Side Torpedoes Mk 43, Mk 44 and Mk 46 (U.S.)
- ... Rocket Thrown Depth Charge Mk 3 Mod 0 (Norwegian)

3.10.2.1 System Integration and Analysis

This area of effort was carried out during the last half of 1960 and the first half of 1961. The scope of the work included the following:

- ... An analysis of the interfaces between the Terne and U. S. equipments to permit their successful marriage. A system functional diagram resulted from this effort. This diagram formed the basis for the preparation of the system functional schematic diagrams because it outlined the requirements for signal transmission and functional selection. It also served to define the input and output signal requirements for the Electronic Frequency Converter Mk 50 Mod 0 (see Item 1) and for the Fire Control Switchboard (Item 2)
- ... A review of the Terne weapon ballistics and the geometry employed for Terne weapon predictions. This resulted in the verification of method employed by the Norwegians for weapon prediction including a proposed method of instrumenting wind corrections. It should be noted that the facility for making corrections for wind effects was included in the Terne Weapon Predictor but the corrections were set to zero because data for the mathematical formulation of rocket response to wind had not been developed due to limited test firings of the Terne Weapon.
- ... A study of Terne sonar stabilization instrumentation resulted in minor modifications to the mathematical equations and equipment constants. These modifications were incorporated into the Norwegian equipment at time of manufacture.
- ... A study of the adequacy of stabilization for the AN/SQS-31 sonar resulted in the instrumentation of the computation of sonar depression from target depth in the Electronic Frequency Converter Mk 50 Mod 0.

- ... A method for emergency (manual) operation evolved from a meeting in Norway during July 1960. In the Norwegian installation on the KNM Bergen, rate of change of relative sonar bearing was employed to compute a deflection angle for Weapon Bearing. The U. S. vessels employed the AN/SQS-31 and 32 sonars and therefore the Bearing section of the Terne Attack Sonar was not purchased by NUOS from KV. Therefore, the Terne Bearing Recorder was not available for the emergency computation of prediction data. The method chosen for the U. S. installation required the use of the (Terne) Computer Mk 142 Mod 0 for computation of weapon bearing and a time-to-fire signal (buzzer at 68° elevation). It was also agreed that no method of emergency system operation would be provided in the event of a computer breakdown.
- ... At the meeting at KV in July 1960, safety of ship and personnel were reviewed. This review resulted in the incorporation of a "standby" phase in the firing sequence to prevent accidental firing of the Terne Weapon. The circuits for interrupting firing power, when the launcher was beyond its firing limits, were changed so that the circuits would "fail safe" in the event of a relay or wiring casualty. In addition, the controls for the "Ready to Fire" lamp on the Terne Firing Panel were modified to include indication that the launcher was in safe-firing sector and also following its weapon roll and tilt orders.
- ... A review of the Norwegian equipment power requirements indicated the need for utilizing the special two-phase 400-cycle generator used on the KNM Bergen for the U. S. installations, as well as the feasibility of using the Norwegian Power Distribution Panel for controlling power flow. Based on Arma's

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recommendation, the decision was made by NUOS to purchase these items from the Norwegians.

- ... At the direction of NUOS, Arma prepared "Mark and Mod Assignment Requests, NAVORD Form 848 (Rev. 6-52)" for all Norwegian furnished equipments.
- ... A study was made of the symbology used by the Norwegians for the geometric functions. The differences between the Norwegian and U.S. symbols were resolved. Where an equivalent U.S. symbol existed, it was assigned in place of the Norwegian symbol, but it became necessary to originate 24 new symbols which were subsequently forwarded to NUOS by Arma letter ERB-E531-96 of 5 October 1960 for approval. The list of symbols, together with their definitions, was approved and distributed by NUOS letter Del-T;TAL;cal - 8510/TERNE of 2 December 1960 for use on the Terne vessels only.
- ... During period August 1960 to April 1961, Arma prepared Cabling diagrams and Cabling Lists of Connections for use by the shipyard in preparing final installation drawings. Due to many last-minute changes in KV equipment drawings, the cabling data had to be revised on a continuing basis during the period April thru August 1961.

3.10.2.2 Preparation of Functional Schematic Diagrams

This area of effort was carried out during the last three months of 1960 and throughout 1961. Whereas the effort under "System Integration and Analysis" established signal flow throughout the system, the preparation of the system functional schematic diagrams was necessary in order to finalize the system installation wiring and cabling requirements for signal and power flow between equipments and to provide a basis for system checkout. Functional schematic diagrams were prepared for the following system circuitry:

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- ... Power Distribution and Supply
- ... Own Ship Inputs
- ... Target Bearing
- ... Target Range
- ... Target Motion
- ... Terne Weapon Orders
- ... Terne Launcher Servo Control
- ... Terne Launcher Firing
- ... Terne Launcher Jettisoning
- ... Terne Launcher Hoist and Weatherhood Controls
- ... Terne Equipment Temperature Indicator and Miscellaneous Functions
- ... Torpedo Tube Mk 32 Preset and Firing
- ... Angle Solver Mk 17 Outputs
- ... Torpedo Tube Mk 25 Synchro Orders
- ... Torpedo Tube Mk 25 Ready Lamp and Firing
- ... Torpedo Tube Mk 25 Preset Controls

The functional schematic diagrams served as guidance plans for the development of the final cabling list of connections and cabling diagrams discussed under "system integration and analysis", above. In addition, the diagrams were used to checkout the shipboard installation at LBNSYD, as well as by the shipyard in preparing the required BUSHIP isometric and elementary wiring diagrams for the ASW Weapon System Mk 1 Mod 0. Following the installation, the diagrams were published in the Supplement to Volume 2 of NAVWEPS OD 15104, as system maintenance and troubleshooting information. The drawings show:

- ... Signal functional flow between equipments
- ... Power distribution to each equipment
- ... Phasing of power
- ... Equipment dials and indicators
- ... Equipment switches and controls
- ... Equipment terminals
- ... Equipment rotating components including type, speed, and direction of rotation
- ... Functional scaling of signals
- ... Shielding of critical circuits

The task of preparing the System Functional Schematic diagrams was made more extensive than originally planned by the fact that initial drawings obtained from KV during the last half of 1960 and in January 1961 proved to be preliminary in nature and were not representative of the

equipments to follow. The final up-to-date drawings were not received until after the equipments were enroute to the US in June 1961. During the period from 1 December 1960 to 1 August 1961 when the Terne equipment drawings were continuously undergoing change, Arma also had to generate the System Functional Schematic diagrams, in order to meet the needs of the shipyard, for they were to serve as the basis for the development of final installation data as indicated above. The last-minute changes in the KV drawings resulted in many revisions to the Arma Functional Schematic Diagrams (several as many as five times) to suit the changed KV drawings as they were received. This in turn resulted in the cabling data for the installation having to be revised on a continuing basis. By working thru the scheduled vacation period in July 1961, Arma was able to supply the shipyard with up-to-date installation information in time for use during the first installation on the DE 1035, which began on 4 August 1961.

Contract Amendment No. 9 of 19 July 1961, directed Arma to "Revise the system functional drawing, cabling diagrams, functional schematic drawings, (and handbooks) in accordance with the data furnished by drawings listed and attached to Record of Conferences at Kongsberg Vaapenfabrikk on 9 June 1961, Kongsberg Vaapenfabrikk letter U/75, 2/61/TH/GA of 7 July 1961, and final revised drawings for AN/SQA-16 transmitter/receiver and transformer box".

The documentation prepared under the "System Integration and Analysis" and "Preparation of Functional Schematic Diagrams" areas of effort and forwarded to NUOS, is summarized below (Note: Documentation supplied to LBNSYD is listed under "System Installation and Checkout", paragraph 3.10.2.3.1.):

- ... Three copies of Arma Engineering Study of Torpedo Mk 37-1 Installation on DE 1033 class, Arma Document A60-47, dated 20 September 1960, were hand-delivered to NUOS in September 1960.
- ... Advanced copies of the System Functional Schematic diagrams and System Cabling drawings for Terne only were hand-delivered to NUOS on 1 May 1961.
- ... Arma Ltr JFMCC-A453-C3446 of 7 June 1961 forwarded one repro copy of each of thirteen System Functional Schematic Diagrams (less Torpedo Mk 37-1 equipment)

and one repro copy of the System Cabling Data Booklet (including Cabling Diagrams) for the ASW Weapon System Mk 1 Mod 0 installation (without Torpedo Mk 37-1 equipment), Arma Document DG-E531-113.

- ... Arma Ltr JFMcC-A453-C4010 of 3 July 1961 forwarded one reproducible copy of Revision No. 1 to Arma Document DG-E531-113, titled ASW Weapon System Mk 1 Mod 0 Cable Data.
- ... At a NUOS-Arma conference at Arma on 10 and 11 August 1961, the NUOS corrections to the System Functional Schematic drawings and Cabling Data forwarded to NUOS on 7 June 1961 were reviewed.
- ... Arma Ltr JFMcC-A453-C4950 of 23 August 1961 forwarded one repro copy of each of the thirteen System Functional Schematic diagrams (without Torpedo Mk 37-1 equipment) and Revision No. 2 to Arma Document DG-E531-113. Note: All of the drawings had been revised to reflect the changes on the "Final" KV equipment drawings and the corrections desired by NUOS.
- ... Arma Ltr JFMcC-A453-C6134 of 16 October 1961 forwarded one repro copy of each of six Functional Schematic diagrams (without Torpedo Mk 37-1 equipment) and Revision No. 3 to Arma Document DG-E531-113. All of these drawings had been revised to reflect the changes requested by LBNSYD during visit by NUOS and Arma in September 1961.
- ... Arma Ltr JFMcC-A453-C734 of 29 January 1962, forwarded one repro copy of each of four Functional Schematic diagrams depicting Torpedo Mk 37-1 equipment and Revision No. 4 to Arma Document DG-E531-113 which had been up-dated to include the cabling data for the Torpedo Mk 37-1 equipments. (Note: A copy of this letter also forwarded these documents to LBNSYD.).

3.10.2.3 System Installation and Checkout

Under this area of effort, Arma was to provide engineering assistance during the system installation and checkout at LBNSYD. Assistance for the installation actually started in July 1960, one year before the first ship's arrival at Long Beach. Arma, acting in a liaison capacity with Kongsberg Vaapenfabrikk in Norway, the Bureau of Ships in Washington, D. C., and the Naval Underwater Ordnance Station at Newport, R. I., supplied installation data to LBNSYD in the following forms:

- ... Copies of Terne equipment drawings (supplied to Arma by KV)
- ... Arma manufactured equipment drawings
- ... Arma prepared switchboard guidance plans
- ... System Functional Schematic diagrams
- ... System Cabling Diagrams
- ... System Cabling Lists of Connections

3.10.2.3.1 Installation Planning

Adequate preparation and planning was considered by Arma to be critical for a successful installation. This effort started at LBNSYD in mid-summer 1960. Mr. J. R. Cole of Code 270 (LBNSYD) was designated project manager, with the installation checkout under the cognizance of Mr. Logan Colby, Code 291 (LBNSYD). The following dates and events summarize Arma's role during the preinstallation checkout period:

19 and 20 April 1960 Trip to LBNSYD, accompanied by NUOS, to acquaint shipyard with Arma's role for Terne, namely: Arma would provide a group of knowledgeable engineers who were readily available to assist in solving problems as they arose, in addition to supplying LBNSYD with installation data.

10 August 1960 Trip to LBNSYD to deliver copies of KV drawings obtained during July trip to Norway.

30 August 1960 Trip to LBNSYD to deliver preliminary Cabling and Power Requirements Data.

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25 October 1960

Trip to LBNSYD to attend technical conference with Norwegian representatives present and to deliver Fire Control Equipment List.

Participants: Captain M. Frihagen, R. N. N.
K. Seim, Terne III Project
Engineer KV
L. Risko, NUOS
E. R. Behn, Arma, and
All Design Division Technical
Codes (LBNSYD).

31 January 1961

Trip to LBNSYD to present comments on Ship Alt Analysis DE 1035-845-1591742, Rev. A, dated 15 December 1960, for Terne Installation and to deliver copies of KV drawings received in December 1960 and January 1961. (Note: LBNSYD letter, Ser. 273-329 of 19 January 1961 invited NUOS, BUWEPS, BUSHIPS, and Arma to this meeting.)

28 March 1961

Trip to LBNSYD to discuss problems related to Terne Installation and to deliver copies of KV drawings obtained during February visit to Norway. Copies of the Arma prepared Functional Schematic diagrams and Cabling Data for ASW Weapon System Mk 1 Mod 0 were also delivered.

8 May 1961

Trip to LBNSYD to deliver Arma's comments on the shipyard-proposed Loading House arrangement and to review plans for the Terne Installation.

31 May and
1 June 1961

Trip to LBNSYD to deliver "Final" Functional Schematic diagrams and Cabling Data for ASW Weapon System Mk 1 Mod 0 and to review Terne installation plans.

22 June 1961

Forwarded "Final" drawings for Terne equipment to LBNSYD by Arma letter ERB-E561-61.

27 June 1961

Forwarded Revision 1 to Cabling Data to LBNSYD by Arma letter ERB-E561-63.

22 August thru
6 Sept. 1961

Trip to LBNSYD to review Terne installation plans and to deliver revised copies of the ASW Weapon System Mk 1 Mod 0 Functional Schematic diagrams and Revision 2 to the Cabling Data. (Note: The revision to the drawings and cabling data was necessary in order to reflect the last-minute changes appearing on the "Final" Terne equipment drawings). Also delivered "Final" Terne equipment drawings received in July and August 1961.

29 Sept. 1961

Forwarded Revision 3 to the ASW Weapon System Mk 1 Mod 0 Cabling Data by Arma letter ERB-E561-87. This revision reflected the changes generated during the visit to LBNSYD in September 1961.

10 thru 12
October 1961

Visit to LBNSYD to review progress of installation and problems relating to the installation of the Terne equipments.

3.10.2.3.2 Shipboard Installation

The shipyard availability for the installation of the Terne weapon system began on 1 August 1961. The DE 1035 entered LBNSYD on 4 August 1961. By September all spaces had been cleared and readied for installation of the Terne weapon system equipments. The installation was to be delayed by about two weeks due to the late arrival of the Terne equipments. Originally the installation on the DE 1035 was scheduled to be ready for cold wire checks on 16 October 1961, but the checks were not begun until 31 October 1961. The checkout was under the cognizance of LBNSYD Code 291. Arma engineers under the direction of NUOS provided technical coordination and assistance as requested by LBNSYD. Technical assistance was also provided by the presence of KV engineers and technicians. In all, the checkout team consisted of:

- ... 4 Representatives from NUOS
- ... 3 Engineers from Arma
- ... 1 Engineer from TDD
- ... 5 Engineers and Technicians from KV
- ... 6 Representatives from LBNSYD

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The installation on the DE 1035 was scheduled to be completed by 19 December 1961, but the ship did not leave the shipyard until 13 February 1962. The checkout of the fire control equipments was completed early in January 1962, but the ship's departure was delayed until a spoking (noise) problem within the AN/SQS-31 sonar was remedied.

The DE 1036 entered the shipyard during the first week in December 1961. The installation checkout was completed on 3 April 1962. The ship departed from LBNSYD on 4 April 1962.

The installation of the ASW Weapon System Mk 1 Mod 0 on the DE 1035 and DE 1036 moved rapidly in an orderly manner due largely to the planning carried out by LBNSYD prior to the shipyard availability. However, certain unforeseen problems arose which are worthy of note:

- ... On the DE 1035, the foundation for the launcher weatherhood was installed in anticipation of receiving the weatherhood in time for installation. When it was learned that the weatherhood would not be received in time for installation, the blast shield was modified to fit the top of the Loading House with the weatherhood foundation in place.
- ... On the DE 1036, the weatherhood foundation, which was installed in accordance with KV furnished drawing KVO-140011, had to be altered to fit the weatherhood upon its arrival because the drawing proved to be in error.
- ... On the DE 1035, after the Launcher was installed and aligned, the Loading House shifted due to the addition of ballast and fuel after leaving the drydock. This required that the Loading Hoists be shifted and realigned and a consequent relocation of the service ring.
- ... On the DE 1035, the AN/SQS-31 sonar had a spoking problem which necessitated that its transducer be moved forward 23 1/4 inches. On the DE 1036, the transducer for its AN/SQS-32 sonar was moved forward 22 1/2 inches to eliminate the spoking problem.

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- ... The AN/SQA-16 (XN-1) sonar Train/Tilt mechanism developed a leak which required that it be modified. Two copper tubes were added from the gear box to the outside of the sea chest, one for draining the oil from the gear box in the event of contamination by water, and the other to provide an atmospheric drain for the Train shaft seals. A layer of neoprene was cemented to the cap on the bottom of the gear box to prevent leakage about the allen head screws which locked the cap in place.
- ... On the DE 1035, the original transducer for the AN/SQA-16 sonar grounded out requiring that it be replaced with the transducer for the DE 1036 installation. Later the original DE 1035 transducer was rewound by the KV engineers and reinstalled on the DE 1035.
- ... The firing mechanism in the Control Panel Mk 265 Mod 0 was modified by replacing its return-to-zero cam with one having a short-dwell at the zero index. This new cam was manufactured by LBNSYD at the direction of the NUOS representative. The substitution of the new cam was done to eliminate oscillation in the Computer Mk 142 Mod 0, which occurred whenever the Pattern potentiometer in the firing mechanism failed to make contact at the zero position with the Terne Firing Panel set for salvo-fire mode.
- ... A problem developed in the air conditioning systems for the Terne equipments due to the fact that the thermostat control for the compressor was located in the cold air duct to the equipment in accordance with the Norwegian drawings. The problem was solved by moving the thermostat control to the "hot" exhaust duct from the equipment to the air conditioning cabinet. This provided a positive control of the equipment temperature.

... The Launcher Roll Firing Limit of ± 8 degrees proved to be unsafe. This was corrected by substituting new cams manufactured by LBNSYD for a Roll Firing Limit of ± 15 degrees. The substitution of the ± 15 degree Roll Firing Limit cam together with the zero to minus 13 degrees Tilt Firing Limit cam allowed firing within a Weapon Bearing Sector of from minus 120 degrees from own ship's bow to a plus 120 degrees and prevented firing within the Weapon Bearing Sector of from 120 degrees to 240 degrees. This was judged to be safe by the commanding officers of the DE 1035 and DE 1036.

3.10.2.3.3 Post Installation Period

The DE 1035 returned to LBNSYD for corrective action during the last two weeks of April 1962. During this period, the following modifications were made to the system:

- ... Train shaft in AN/SQA-16 (XN-1) sonar Train/Tilt mechanism was pinned as recommended by KV. This was done to eliminate the possibility of slippage which had occurred in the sonar aboard the Norwegian vessel, the KNM Bergen.
- ... Operation of Loading Door in Terne Missile Magazine was rendered satisfactory by structurally strengthening its mounting.
- ... Springs on solenoid-operated locking pins in Dud-Jettison Unit were replaced with new type (stronger) springs supplied by KV. This was done to eliminate hang-up of the locking pins.
- ... Attack Director Mk 5 was overhauled by a Librascope Field Service Engineer, who found a loose clamp in the range section which probably accounted for the repeated failure of the attack director to transmit a reliable range order. The erratic behavior of the attack director had been noted during the installation checkout and the period preceding the technical evaluation.

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- ... Illumination (Red Light) for the Torpedo Mk 32 Memory Status Panel located above the Control Panel Mk 264 was provided. (The yard had failed to install this illumination during the installation availability period.)
- ... Two 20-ampere fuses were added to protect the 24 VDC supply from the 24 volt battery to the Terne Firing circuit in the Loading House. This was done to prevent damage to the wiring in the event of an accidental short of the "hot" wire to ground because one side of the battery is always grounded.
Note: At Key West during the OpTevFor evaluation, it was necessary to substitute 25-ampere fuses because it was found that the 20-ampere fuses would blow when the Terne Rockets were fired.
- ... A clipping circuit was added by KV engineer in the input from the AN/SQA-16 (XN-1) sonar transducer to the pre-amplifiers in the Transmitter/Receiver to prevent saturation of the amplifiers on strong signal returns. NDRE engineers had performed this modification on the KNM Bergen.
- ... The own ship speed input receiver in the Computer Mk 142 Mod 0 was modified. The original Type IX Synchronous Torque receiver was replaced by a 31TR6 synchro at the direction of NUOS. LBNSYD manufactured the necessary adapter for mounting the new synchro. (Note: This modification was also done on the DE 1036 while the ship was at San Diego, California, during April 1962).

While the DE 1035 was at Key West, Fla., during May and June 1962, the following modifications to equipments were made by an Arma engineer, assisted by a NUOS technician:

- ... New underwater trajectory ballistic data was introduced into the Computer Mk 142 Mod 0. This new data had been supplied by KV in April 1962. Concurrently, with the introduction of the new ballistic data, the own ship speed test signal for the computer

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was changed. As originally designed, the UBFC switchboard provided, along with other test signals, an own ship speed test signal of 20 knots when the ASW Weapon System Mk 1 Mod 0 was placed in Terne Test mode for performing the System Readiness Checks in NAVWEPS OD 15104. During checkout at LBNSYD and also during the operations that followed, it was observed that the torque receiver for own ship speed in the Computer Mk 142 tended to hang-up at zero knots provided the ship's Pitlog input was zero at the time the system was switched from Terne (normal operation) to Terne Test mode. To eliminate this condition, the decision was made to change the Test signal to Computer Mk 142 from 20 knots to 13.33 knots. Switch 19 in the UBFC switchboard was modified to provide an own ship speed test signal of 13.33 knots. The wiring changes made to this switch are given below:

Lead from 17F to 22F was changed to 17F to 21F.
Jumper from 21F to 23F was changed to 21F to 22F.
Lead from 12F to 21F was changed to 12F to 23F.

(Note: The above described changes were also made aboard the DE 1036 while the ship was at LBNSYD in June 1962).

... After the ship arrived in Key West in May 1962, a casualty to its Sonar AN/SQA-16 (XN-1) Transducer Train/Tilt mechanism occurred when the crew attempted to lower the transducer after having raised it during a shipboard demonstration. The nature of the casualty was that the four fingers which secure the Train/Tilt Drive mechanism to its Hoist mechanism pulled out of the V-shaped recesses in which they rest. The fingers were secured in place by allen-headed set screws which were not designed to resist tension. When the hoist was lowered a tension on the fingers developed due to sea-growth on the guide rails for the Steady Bracket in the sea chest. This tension

caused the fingers to pull free from the V-shaped recesses. After the Transducer Train/Tilt mechanism had been repaired and reinstalled aboard ship, the unit was modified to prevent a reoccurrence of the above casualty. The modification consisted of physically "strapping" two diametrically opposite fingers to the base on which they rest, see NAVSHIPS 94181, Figure 1-3-41. A 3/16 inch by 5/8 inch stainless steel bar about four inches long (bent to fit the contour of the face of the finger where it meets the base) was secured in place on each finger by three 5/16 inch allen head screws 3/4 inch long, one in the base and two in the finger.

- ... The Computer Mk 142 Mod 0 value of pattern spacing for Terne Weapon salvo firing was changed from 12 yards to 20 yards for the OPTEVFOR evaluation.
- ... The Dud-Jettison Unit Mk 110 Mod 0 was modified to permit shortening of the Jettison-Rocket umbilical cords to 16-1/2 inches overall length from approximately 30 inches. Modification consisted of adding brackets for mounting the receptacles for the umbilical cords at right angles to their original positions. The brackets for remounting the receptacles were supplied by KV and the modification was required to eliminate the probability of damage to the umbilical cords from the blast of adjacent Dud-Jettison rockets, such as occurred during the BUWEPS Technical Evaluation at San Diego, Calif., and also on the KNM Bergen during its OPTEVFOR Evaluation at Key West, Fla., in April and May 1962. The modification was proven to be effective during the OPTEVFOR tests in June 1962.

The DE 1036 returned to LBNSYD in May 1962, at the direction of BUSHIPS, for the removal of its Transducer and associated Train/Tilt mechanism for the Terne AN/SQA-16 (XN-1) sonar. Concurrently, the transducer for the AN/SQS-32 sonar was returned to its original position and the ship's 185-inch sonar dome was replaced with a 100-inch dome. Following the removal of the AN/SQA-16(XN-1) sonar transducer, the ship operated using the Depth/Tilt handwheel on the Control Indicator for making manual depth settings.

After the DE 1036 had left LBNSYD in April 1962, the ship found that the weatherhood would not remain closed overnight. To overcome this problem, a Greer engineer was called in by LBNSYD upon the ship's return to the yard in May 1962. The Greer engineer recommended that the accumulator in the hydraulic line for closing the weatherhood be precharged to 60 percent of the working pressure of 1200 psi, or 720 psi. Previously, the accumulator had been precharged to 1200 psi which was equivalent to the maximum pressure generated in the lines as the weatherhood is closed. With the accumulator precharged to 720 psi, the weatherhood remained closed overnight. But it was found during a subsequent checkout of the Launcher and Weatherhood System, that the weatherhood would not remain fully open once it had been opened. This precluded operating the Launcher because of interlock switches which prevent the launcher from operating when the weatherhood is not fully open. The ship departed from the shipyard on 11 June 1962 for San Diego, California. While the ship was at NRF, San Diego, a study of the problem by an Arma engineer revealed that the accumulator was being charged on the opening cycle to 1200 psi and that this pressure on the "close" side of the piston, after the weatherhood was open, would force the weatherhood to slowly close until the pressure in the accumulator reached its precharged pressure of 720 psi. This was due to oil on the "open" side of the piston, which was supposed to hold the weatherhood open, slowly draining off through the valves on the Hydraulic Control Panel. Acting upon the recommendation of the Arma engineer, a relief-valve, with a setting of 700 psi, was installed in the pressure line to the "open" side of the piston that actuates the weatherhood. With the accumulator precharged to 800 psi, the accumulator remained out of action when the weatherhood was opened and performed its proper function when the weatherhood was closed. On final checkout, the weatherhood and loading hoist hydraulic system was observed to function correctly.

3.10.2.3.4 Current Installation Status Report

NUOS letter Te3:FWK:jan-8510/TERNE-Serial 0442 of 3 May 1963 directed Arma to prepare a summary report outlining the current status of the installations on the U.S.S. Charles Berry (DE 1035) and on the U.S.S. McMorris (DE 1036). The report was prepared and published as Arma Document, DR 411-63-7, in July 1963.

3.10.2.4 Training

Under this area of effort, Arma was to provide limited training for the personnel of the DE 1035 and DE 1036 in the operation and maintenance of the Terne weapon system equipments. The Training Program was to consist of two phases:

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- ... In-plant Training. This was to take the form of one class (30 students) for a two-week period prior to system installation and checkout on the first Terne vessel. The purpose of the class was to provide the ship's personnel with technical information essential to the operation and maintenance of the Terne Weapon system equipments.
- ... On-board Training. This portion of the program was to take place during the system installation checkout of the equipments aboard the Terne vessels. System checkout procedures and equipment operation and maintenance were to be stressed.

Performance - Classroom Training: The program for the classroom training had its inception on 25 January 1961 at a conference at Arma attended by Messrs. Ramras and Burwell of Bureau of Naval Personnel. It became apparent that the in-plant training should be conducted at LBNSYD, rather than at Arma, because of convenience to the government and by reason that Arma and KV personnel needed for the training would be at Long Beach for the Terne installation. It was further established that the in-plant, hereinafter termed classroom training would be conducted during period 21 August to 1 September 1961. Messrs. Ramras and Burwell, in addition to reviewing Arma's plans for the training program, were concerned with receiving information on Terne weapon system operation in order to prepare BUPERS job analysis and manning requirements for DE-1035 and DE-1036. A meeting was scheduled for 20 February 1961 to review the Terne Weapon System manning and operation requirements.

The initial planning for the classroom training culminated in Arma Document DG-E531-85, dated 31 January 1961, entitled "Training Program for TERNE-U.S. Equipments." This document set forth the general objectives and purposes of the program and included a

- ... Syllabus of the classroom training
- ... Training Course Outline
- ... Daily schedule of classes

A copy of Arma Document DG-E531-85 was hand-delivered to NUOS on 10 February 1961 for a Terne program review conference. The decision was made that the class-room training should be at LBNSYD and that NUOS would initiate the appropriate action to BUPERS, BUSHIPS, and the LBNSYD.

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Conference at Arma on 20 February 1961 with BUPERS (Mr. Burwell) reviewed Terne Weapon system operation and manning requirements. The duties for the key personnel to staff the Terne weapon system were defined and an informal copy of the summary of these duties was given to BUPERS.

Conference at Arma on 14 March 1961 with BUPERS (Mr. Burwell) to further review Terne Weapon system operation and manning requirements. Arma prepared job descriptions of SQC, S01, GM1, GM2, GM3, TM1 and TM3 and supplied the information to BUPERS in May 1961. This information was required by BUPERS for documenting the Terne III Weapon System "Personnel and Training Requirements" which was published in June 1961.

NUOS letter Del-T:LFR:bju-8510/TERNE of 24 March 1961 (NOTAL) set forth general information relating to the training program for Fleet personnel in the operation and maintenance of the Terne weapon system. The letter established that the classroom training would be at LBNSYD.

Conference at Kongsberg Vaapenfabrikk in April 1961 reviewed KV engineering services required for training and the scope and objectives of the training program.

Conference at Arma on 21 June 1961 with BuPers (Mr. Burwell) reviewed Terne weapon system operation and plans for the classroom training at LBNSYD. A copy of the Arma prepared Terne weapon system operating procedure for the ASW Weapon System Mk 1 Mod 0 manual was given to BUPERS.

Final planning details for conducting the classroom training were reviewed during a conference at LBNSYD on 28 June 1961. Arrangements were made for the use of a classroom and facilities for storage of classified materials required for the training course. The Training Department at LBNSYD, Code 183, was to coordinate the attendance of shipyard personnel and the record keeping associated with the classroom training.

Preparation of the training lecture outlines was completed in June 1961. Thirty (30) copies of Arma Document DG-E531-118, entitled "Training Program for Terne - US Equipments - Classroom Training Lecture Topics" were printed for distribution to the class attendants. The document set forth the training objectives and contained a synopsis of each lecture including:

- ... Training goals
- ... Reference publications and source materials
- ... Suggested Trainee preparation
- ... Outline of lecture presentation.

NUOS letter Del-T:LFR:inc - 8510/TERNE of 9 August 1961 (NOTAL) confirmed that the classroom training would be held at LBNSYD during period 21 August through 1 September 1961 and invited all addressees to send interested personnel.

The classroom training was conducted in accordance with the terms of the subject contract as scheduled. Attendance by activity, including observers, was as follows:

- ... NUOS 3
- ... BUPERS 1
- ... LBNSYD 32 (represents total persons part time)
- ... DE 1035. 24 (4 Officers and 20 Enlisted men)
- ... DE 1036. 3* (1 Officer and 2 Enlisted men)

The classroom training was supervised by Mr. E. R. Behn of Arma. The training lectures were given by:

- ... Six engineers from Arma
- ... One engineer from NDRE (Norwegian Defense Research Establishment)
- ... Two engineers from Kongsberg Vaapenfabrikk, Norway

At the close of the instruction, the LBNSYD Training Department awarded a Department of the Navy Certificate of Training to the ship and shipyard personnel who had attended 80 percent of the training time.

Prior to the class on 27 August 1961, 15 copies each of the preliminary manuscripts for the following instruction books were procured by Arma and shipped to LBNSYD to serve as reference material for the trainees:

*Attendance limited because ship was at sea with WESPAC.

... Chapter 3 (System Operation)from NAVWEPS OD 15104	
... NAVWEPS OP 3030	Analog Computer Mk 142 Mod 0
... NAVWEPS OP 3031	Position Indicator Mk 99 Mod 0 and Indicator Panel Mk 263 Mod 0
... NAVWEPS OP 3032	Firing Panel Mk 262 Mod 0
... NAVWEPS OP 3033	Rocket Thrown Depth Charge Mk 3 Mod 0
... NAVWEPS OP 3034	Terne Launcher and Loading House Equipment
... NAVWEPS OP 3036	Dud Jettisoning Rocket Mk 1 Mod 0
... NAVWEPS OP 3037	Power Distribution Panel Mk 261 Mod 0
... NAVSHIPS 94181	Depth Sonar AN/SQA-16 (XN-1)

At the completion of the classroom training the above instruction books were designated for delivery to the following activities by NUOS:

... DE 1035	4 copies of each
... DE 1036	4 copies of each
... LBNSYD	3 copies of each
... OPTEVFOR	2 copies of each
... Reserved for use by NUOS, KV, and Arma personnel during shipyard installation of Terne	2 copies of each

LBNSYD letter of 8 January 1962 to NUOS requested that necessary action be taken to provide the personnel from the DE 1036 with schooling comparable to the classroom training of August 1961. During ensuing discussions between NUOS and Arma, it was established that a one-week classroom training program for the personnel from the DE 1036 would be given at LBNSYD with emphasis on the basic concepts of system operation and equipment functional description. The presentation would be by three engineers from Arma, two of which were at LBNSYD for the installation on the DE 1036.

NUOS letter Te2c:FWK;dar-8510/TERNE of 17 January 1962 advised LBNSYD that Arma had been instructed to provide a suitable schooling program for the personnel from the DE 1036 and asked that the necessary classroom facilities be provided. On 24 January 1962, a daily schedule of classes for a one-week Terne classroom training program was hand-delivered to the Training Department at LBNSYD who were to assist Arma in preparing for the classroom presentation.

The classroom training for the DE 1036 was conducted during the week of 29 January to 2 February 1962. The training aids and classroom training lecture outlines (Arma Document DG-E531-118) from the August 1961 class were used in making the lecture presentations. The course of instruction was attended by:

- ... 7 officers from the DE 1036, including the commanding officer.
- ... 13 enlisted men from DE 1036
- ... 2 enlisted men from DE 1035

Certificates of attendance were presented to each of the fifteen enlisted men by the LBNSYD Training Department.

Performance - Shipboard Training: Shipboard training was instituted on both the DE 1035 and the DE 1036 as soon as the cold-wire check of the ASW Weapon System Mk 1 Mod 0 installation had been completed and the equipment could be operated. The training was given on a day to day basis throughout the checkout period and emphasized operation of the system equipments and the system checkout procedures prescribed in Volume 3 of NAVWEPS OD 15104, entitled "ASW Weapon System MK 1 Mod 0, System Readiness Checks". Technical information was disseminated to the ship's personnel in the operation and maintenance of their particular equipment and in the use of the system manuals and documentation as aids in maintaining the system.

Completion of Training: Arma letter JFMcC-A453-C2869 of 17 April 1962 (copy to NPO Bklyn) advised NUOS that Arma had completed the requirements for training as specified under the terms of the contract.

Arma letter JFMcC-A453-C3548 of 18 May 1962 informed BUPERS that Arma had completed the Terne training effort.

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3.10.3 CONTRACT ITEM 10c: MISSILE COMPONENT EVALUATION

Scope: This program was to provide for engineering services to initiate appropriate action for timely completion of evaluations of missile components by the

- ... Naval Weapons Laboratory-for performance of explosive environmental and packaging tests to verify Norwegian missile aeroballistics data, and
- ... Naval Torpedo Station-for performance of hydroballistic tests to verify existing Norwegian data.

These activities were funded for this work under separate contracts by Naval Underwater Ordnance Station.

Clarification of Scope: Subsequent to the contract authorization, it became the intent of NUOS to monitor the missile component evaluation itself. NPO Bklyn issued Modification 2, dated 9 November 1960, limiting the effort to be performed under this task.

As a result of meeting held at NUOS on 22 November 1960, the Arma report of the conference (Arma Ltr ERB-E531-123 of 25 November 1960), and NUOS letter Del-T:TAL:cal-8510/TERNE of 8 December 1960, it became Arma's role to provide engineering assistance and support to NUOS during the evaluation programs, by keeping informed on the progress of the evaluations so that appropriate recommendations could be initiated to assure that optimum utilization be obtained of KV personnel, equipment and information.

Performance: Programs for Naval activities were established by NUOS with starting dates and schedules based on receipt of the missile components to be tested; rocket motors, igniters, boosters and fuzes. These programs, in brief, were as follows:

Naval Torpedo Station, Keyport, Washington

Hydro-ballistic tests were to be performed using a fabricated nose piece instead of the Terne missile nose cone to verify Norwegian data furnished by KV with respect to underwater travel mainly. These tests were to be made on a YF vessel using a single rail launcher supplied by KV. This program began in June 1961. The data generated by Keyport was to be furnished to Dahlgren to supplement the latter aero-ballistic data.

Naval Weapons Laboratory - Dahlgren, Virginia

This activity was to investigate the safety handling, air ballistics and range elevation characteristics of the missile. Missile firings also were to be made from a shore based single rail launcher.

Naval Propellant Plant - Indian Head, Maryland

This activity was to conduct demolition tests including disarming and disposal techniques. The results of these tests were furnished to Dahlgren and NUOS. The details of the disarming and disposal procedures for the TERNE missile is published in EODL-6230.

Engineering services performed by Arma are summarized chronologically, as follows:

2 December 1960

Visit to KV, Norway

During a conference at KV, Arma assisted NUOS in relating the Dahlgren and Keyport programs. The photographs and drawings of the single rail launcher and mounting arrangement also were obtained and furnished Dahlgren via NUOS, 10 January 1961.

28 February 1961

Conference at NUOS to discuss the Missile Evaluation Programs. The details of the programs at the various activities were reviewed and details of the tests to be performed were discussed. Arma assisted in the review of the Dahlgren proposed tests, including the environmental tests and in the review of the proposed Keyport tests. NUOS was concerned with investigating the use of Distance Measuring Equipment to determine exact miss distance of the missile from the target.

25 May 1961

Conference at NUOS to Prepare for General Program Conference on 7 June 1961 at Dahlgren. Program schedules were revised in accordance with KV latest delivery dates and were reviewed; the status of Keyport preparation for testing was discussed.

7 June 1961

Planning Conference at Dahlgren, Va.
(NWL, KTS, NUOS, BUWEPS, Arma).

The entire program was reviewed and anticipated problem areas were discussed. During this meeting Arma was requested by NUOS to furnish Dahlgren with the necessary parameters for the preparation of range tables. This included expected propellant temperature limits, launcher trunnion height and underwater depth limits.

19 June 1961

Conference at NUOS to Discuss Status of Program. Range tables were discussed and finalized for Dahlgren. Arma reviewed the propellant upper temperature limit of 113°F and the rocket motor specification limit of 145°F which are not compatible. It was decided that the tests at Dahlgren could be suspended until the upper temperature limit could be clarified since KV had specified that any temperature exceeding this (113°F) might be dangerous.

31 August 1961

Conference at Keyport to Review Results of Preliminary Firings. The results of three of five firings at 45° elevation were reviewed with Keyport personnel. The results did not agree with KV findings and it was at this meeting that concern was indicated as to the correctness of the computer ballistics since the plots showed considerably more (1/3 more) forward underwater travel than the KV data. Copies of the Keyport data were obtained and analyzed at Arma and discussed with NUOS on 27 September, 1961.

27 September 1961

Conference at NUOS to Review Keyport Preliminary Results. Underwater travel curves were plotted to depict Keyport preliminary data versus Norwegian data. The Keyport best data was obtained from

three 45° elevation firings, at 46° water entry angles. The Norwegian data at 46° water entry angles was extrapolated so that the splash points coincided (zero depth). The plots showed that the Keyport curve depicted less forward travel from 0 to approximately 430 feet depth, crossed the Norwegian curve, then at 580 feet indicated 30 feet additional forward travel. Maximum deviation between the two curves was approximately 40 feet. Since these results were from 45° elevation angle firings, it was agreed that ballistics changes to correct the Terne computer computation would not be considered until data from new firings at 55°, 65° and 75° angles had been received from Keyport. This data would then be plotted against the Norwegian data for these elevations, and compared.

It was determined from the firings that sinking rate, the vertical component of underwater travel, checked closely with the Norwegian data for 46° water entry angle.

Tests of missile components at Dahlgren were delayed at this time because of inadequate supply of fuzes from KV (only 19 of 125 expected fuzes having been delivered). Though Dahlgren firing of 25 exercise rounds were to begin after receipt of Keyport data, it was decided that Dahlgren should begin firings immediately.

Planning for the BUWEPS evaluation was begun with NUOS considering firing of practice rounds daily at a maneuverable target. This evaluation and the results of these tests are recorded in section 3.10(d) BUWEPS and OPTEVFOR evaluations.

Keyport firings continued to show more forward underwater travel than the Norwegian data. KV was notified of this and requested to verify the original data. Their reply stated that new data would be furnished.

Operating in close liaison with NUOS, a rocket motor igniter tester was designed and built for use at Seal Beach to check the electrical continuity of igniters delivered by KV prior to the BUWEPS evaluation. The igniter tester was handcarried to LBNSYD and delivered to Mr. W. Kamph of NUOS on 1 February 1962.

9 March 1962

Conference at NWL, Dahlgren, to Review and Discuss Dahlgren Missile Evaluation Results. The Dahlgren results were not final in that the small sample of rounds fired were not adequate to determine either range dependence on propellant temperature for a lot fired, or verification of Norwegian hydroballistics data. However, the results of three firings at varying propellant temperatures (32°F , 59°F and 113°F) for one propellant lot, showed 40 yds greater range at the 113°F temperature than the Norwegian data. NUOS was requested to obtain maximum velocity data for this propellant lot. This was later obtained and furnished. Deviation in maximum time of flight was also noted - where the latest KV data showed 18.50 seconds for this test lot. Dahlgren results indicated 18.75 seconds. This was significant because the time of flight switch setting on Analog Computer Mk 142 Mod 0 would have to be changed to 18.75 seconds if the Norwegian data could not be verified.

At the time, Keyport had furnished all data on 45° elevation firings, but firings had not been completed nor data yet analyzed of 55° , 65° and 75° elevation angles.

The rocket motor tests were completed satisfactorily but igniter tests were in progress.

Final Norwegian data for hydroballistics was received 20 April 1962 by KV ltr U/153/62/OW/Ga;P2 of 16 April 1962. This data was analyzed and plotted and the Keyport data which was not complete, was plotted against it. The curves were in close agreement with the Keyport data for depths down to about 300 feet; however, below 300 feet the Keyport data depicted a greater forward underwater travel than the KV data. Dahlgren was

furnished the KV hydroballistic data, which was known to have been determined theoretically for depths below 300 feet, by Arma ltr JFMCC-A453-C3185 of 25 April 1962.

13 June 1962

Conference at NWL, Dahlgren, to Discuss Project Hero and Fuze Problems. Tests of the rocket motor igniter indicated that the igniter might be influenced by shipboard radio frequencies and plans were made to check the shipboard environment after the OPTEVFOR evaluation. The Dud-Jettisoning Rocket MK 1 Mod 0 was also presumed susceptible because of its unshielded umbilical cord connection to its igniter. The tests to check susceptibility to electromagnetic radiation of missile components was called Project Hero.

As the fuzes did not pass the jolt, jumble and vibration tests conditions, KV was to expedite a fix, so that the OPTEVFOR evaluation would not be delayed. It was also reported that 20 of 90 firings on the KNM Bergen indicated premature detonations; however, it was stated that KV was working on this problem.

The hydroballistics test results showed more forward underwater travel than the Norwegian data and in addition, the excessive yawing at 75° firings indicated poor aero and underwater trajectory stability.

In May 1962, the decision was made at NUOS to change the ballistics in Analog Computer MK 142 Mod 0. This is recorded in section 3.10b, Installation, of this report. During this period the manuscript of NAVWEPS OD 3030, Analog Computer MK 142 Mod 0, was also updated to include the new ballistics information by revising the computer test problems.

3 July 1962

Conference at BUWEPS, Washington, D. C.
to discuss Fuze Problem Indicated by
Dahlgren tests. This was a general technical
conference attended by representatives of KV,
BUWEPS RU-32, RUSD-212; NWL; PWS-52;
OPTEVFOR; NUOS; and Arma.

Plans were made for KV to provide fuze modifications within six weeks and submit modified fuzes for recheck by Dahlgren. A procedure for handling the fuzes was to be prepared by NUOS. The problem of premature detonation was due to noise and KV indicated progress in achieving a fix - which would make the fuze insensitive for 500 to 600 milli-seconds after water entry and fully sensitive at 1400 to 1500 milliseconds; as compared with original parameters of 300 and 900 milliseconds for these same conditions.

Schedules for delivery of completely modified fuzes were agreed upon and KV personnel would "insert" interim fixes and do all handling of missile explosive services during OPTEV-FOR tests.

11 October 1962 Conference at Dahlgren to Review Re-Tests of Fuzes. The re-tests indicated that the modified fuzes were safe to handle and fuzes were to be ordered for ship's complement.

Tests were planned to check RF susceptibility of Dud-Jettisoning Rocket Mk 1 Mod 0 igniter. However, no action was taken to correct rocket motor igniter susceptibility until after completion of RF tests of dud jettisoning rocket igniter (Operation Hero).

Shipboard Test Set: This equipment designated, Rocket Fuze Electronic Test Set MK 429 Mod 0, was furnished by KV for DE 1035 and DE 1036. At NUOS request, operating instructions were prepared for the use of the test set by shipboard personnel. These instructions set forth procedures for making electrical continuity tests and charging the battery of Rocket Fuze

Mk 194 Mod 0. The instructions were incorporated into the instruction manual for the Rocket Thrown Depth Charge Mk 3 Mod 0, NAVWEPS OP 3033, End Delivery Item 7.h.

3.10.4 CONTRACT ITEM:10d: BUWEPS AND OPTEVFOR EVALUATIONS

Scope: Under this task, engineering support to NUOS was to be provided by Arma during the BUWEPS Technical Evaluation and the OPTEVFOR Operational Evaluation of one Terne Weapon System on a U.S. vessel.

The BUWEPS Technical Evaluation had the objective of proving that:

- ... The integration of system equipments was satisfactory.
- ... The Terne weapon handling facilities were adequate.
- ... The system was ready for the OPTEVFOR Operational Evaluation to follow.

The technical evaluation also provided an opportunity for indoctrination of the ship's crew relative to the recommended operational procedures prescribed in Chapter 3 of NAVWEPS OD 15104, as well as proving the adequacy of these operational procedures.

The OPTEVFOR Operational Evaluation, performed at Key West, Fla., during June and July 1962, had as its objectives:

- ... Evaluation of overall system performance
- ... Evaluation of the adequacy of Terne safety features
- ... Evaluation of Terne Fuse performance
- ... Verification of Terne Weapon Ballistic Data

Performance: In accordance with a conference at NUOS on 28 September, 1961, a program for developing the technical evaluation requirements was initiated in September 1961. The objective was to:

- ... Determine needed data to be recorded in evaluating system performance.
- ... Determine the functional requirements for a Data Acquisition System.

- ... Determine needed auxilliary Naval services and facilities.

The initial study resulted in two preliminary Arma documents:

- ... DG-E531-140, entitled "Performance Data from BuWeps Terne Evaluation". This document contained plans and recommendations relative to the type of data to be recorded and detailed the requirements for a data acquisition system.
- ... DG-E531-141, entitled "ASW Weapon System Mk I Mod 0 BuWeps Evaluation". This document outlined the scope of the proposed technical evaluation and summarized the types of tests and runs to be performed. It also listed the material and Naval services required for the proposed tests.

Two copies of each of the above documents were hand-delivered to NUOS on 19 October 1961 for a planning conference relative to the BUWEPS Technical Evaluation. At this conference the proposed plans were reviewed and accepted by NUOS with minor modifications. The discussion resulted in the decision that Arma should perform the following efforts:

- ... Develop requirement for a face plate layout of a Data Panel to be purchased by NUOS from Librascope.
- ... Develop the required cabling plans and data for the installation of the Data Panel aboard the DE 1035. (Note: It was decided that NUOS would ask the LBNSYD to install the necessary cables for routing the required system functions to a common junction box and that NUOS technicians would install the cables from the junction box to the Data Panel.)
- ... Develop operation plans for the BUWEPS Technical Evaluation. The operation plans were to include run plans for both stationary target and submarine tracking firing runs.
- ... Act in an advisory capacity throughout the BUWEPS Technical Evaluation including data reduction by the facilities at NUOS.

DG-E531-323

In accordance with the decisions reached during the October meeting at NUOS, Arma developed the following Data Acquisition System plans which were forwarded to NUOS by Arma letter JFMCC-A450-C6949, dated 17 November, 1961 (Note: The plans were also forwarded to the Arma engineer at Long Beach, California, where they were used by LBNSYD to install the required cabling for the Data Acquisition System.):

- ... Arma Sketch DG-E531-128 entitled "Terne System Evaluation". This drawing showed the components of the attack error to be considered in evaluating system performance.
- ... Arma Sketch DG-E531-142 entitled "Terne Data Panel Layout". This drawing showed the proposed face plate layout for the Data Panel to be procured by NUOS.
- ... Arma Sketch DG-E531-148 entitled "ASW WEAPON SYSTEM MK 1 MOD 0 CABLING DIAGRAM FOR BUWEPS EVALUATION". This drawing showed the cables (type and size) to be installed by LBNSYD to a junction box in UB Plot.
- ... Arma Document DG-E531-149 entitled "BUWEPS EVALUATION ASW WEAPON SYSTEM MK 1 MOD 0 CABLING DATA". This booklet contained a list of connections for the cables shown on Arma Sketch DG-E531-148.
- ... Arma Sketch DG-E531-153 entitled "Recording System Block Diagram". This drawing showed the functional flow of information from the junction box in UB Plot to the Data Acquisition System equipments.
- ... Arma Sketch DG-E531-154 entitled "Recommended Data Coordinating Panel Functional Diagram". This drawing prescribed the requirements for the relay and switching circuits to be instrumented into the control panel for the Data Acquisition System equipment.

In December 1961, Arma completed a preliminary operation plan for the BUWEPS Technical Evaluation. This document, Arma DG-E531-159, entitled "Detailed Test Plan for Technical Evaluation for Terne", was hand-delivered to NUOS on 20 December 1961 for a conference to review the

adequacy of the proposed plan. Following this conference, work was started on a final operation plan which resulted in Arma publishing twenty copies of each of the following booklets:

- ... Arma Document DG-E531-172, entitled "Detailed Operating Plan for Terne Technical Evaluation", contained the following information:
 - Outline of test objectives.
 - Scope of tests.
 - Summary of required services and test equipment.
 - Description of the data recording system.
 - General description of each test.
 - Data reduction plan for evaluation of recorded test data.
- ... Arma Document DG-E531-173, entitled "Detailed Operating Instructions for Terne Technical Evaluation", contained detailed operating instructions for all personnel activity engaged in evaluating the Terne weapon system, including the target submarine and spotting helicopter. This booklet also contained a description of the run geometries and detailed run plans.
- ... Arma Document DG-E531-174, entitled "Data Log Sheets for Terne Technical Evaluation," contained sufficient log sheet forms for recording data essential to the evaluation of the results of the tests. These log sheet forms were to be filled in by the NUOS team aboard the DE 1035 and the Naval personnel on the target submarine. (Note: only five copies of this booklet were published.)

The above booklets were hand-delivered to Mr. W. Kamph of NUOS at San Diego, California, on 9 March 1961, and served as final documentation for the technical evaluation.

The NUOS purchased Data Recording Equipment was installed on the DE 1035 during the first two weeks of February 1962, while the ship was at LBNSYD. The installation was made by two NUOS technicians with an Arma engineer acting in an advisory capacity.

The BUWEPS Technical Evaluation was conducted at sea, off the coast of San Diego, Calif., during the period 12 to 23 March 1962. The evaluation was under the technical direction of Mr. W. Kamph of NUOS with an assist from two Arma engineers. CNO letter Op-712 c/fw; Ser. 0178P71 of 30 November 1961 provided the evaluation directive. The data recording equipment aboard the DE 1035 was operated by two technicians from NUOS. The technical evaluation was comprised of the following tests:

- ... Weapon Handling Tests, which proved that the Terne weapon could be loaded, jettisoned and fired in the at-sea environment.
- ... Four Stationary Target Runs, which were attacks made on a stationary submerged sonar target suspended from a buoy. On each run twelve lightweight practice missiles were fired.
- ... One Sonar Run, which utilized a maneuvering target submarine to check the depth determining capability of the Terne AN/SQA-16 (XN-1) sonar.
- ... Six Weapon Runs, which were attacks on a target submarine making prescribed maneuvers by firing lightweight practice missiles at it.

The tests performed during the technical evaluation served to show that the operation of the Terne Weapon components of ASW Weapon System Mk 1 Mod 0 was satisfactory for the OPTEVFOR evaluation to follow, with the exception of the Terne Depth Determining Sonar AN/SQA-16 (XN-1) and certain weapon handling and storage facilities which were partially corrected by LBNSYD before the DE 1035 proceeded to Key West, Fla.

The data accumulated during the technical evaluation at San Diego was reduced by the data processing facility at NUOS with Arma rendering assistance in developing a program for interpretation of the data. This program culminated in a report, Arma document DG-E531-368 of 1 March 1963, entitled "BUWEPS Technical Evaluation of ASW Weapon System MK 1 Mod 0 installed on USS Charles Berry (DE 1035)". This report describes the scope and objectives of the technical evaluation and presents the analyzed test results in terms of overall system performance error. The report also contains conclusions which bear out the fact that the Terne Weapon System equipments are highly reliable and accurate instruments capable of directing a missile to hit a low-or medium-speed submarine.

During the OPTEVFOR Operational Evaluation at Key West, Fla., Arma's role was limited to system maintenance and improvement. Tests designed to evaluate and peak the dynamic performance of the Terne weapon system were performed during period 25 June to 3 July 1962. The results of these tests are included under Section 6 of the technical evaluation report, Arma Document DG-E531-368.

3.10.5 CONTRACT ITEM 10e RELATED STUDIES

Scope: This effort provided for Engineering Services in the form of Engineering studies to determine:

1. maximum effective use of sonar depth information.
2. optimum vessel size for Terne III missile and Fire Control System.

Change in Scope: In June 1960, Arma performed a study to determine whether an acceptable launch doctrine could be used with over-the-side Torpedoes MK 44 Mods 1, 2, 3, 4 and Mk 46 Mod 0 and what mechanical aids, if any, would be required. The study "Fire Control Requirements for Launching Over-the-Side Torpedoes" published as Arma document DR-E652-21 dated 12 October 1960, concluded that:

- ... Course-to-steer and prediction computation is not required for Torpedoes MK 44 Mods 1, 2, 3, 4 and MK 46 Mod 0. Doctrine firing yielded satisfactory acquisition probability.
- ... Attack Director MK 5 can be used for Torpedo MK 44 Mod 0 by setting doctrine depth and doctrine depth charge sinking rate.
- ... Recommended development of an optimum doctrine for launching torpedoes.

Contract Modification 5, dated 28 March 1961, directed Arma to:

- ... Determine the optimum launch doctrine for Torpedoes MK 44 and MK 46.
- ... Delineate the displays and/or computations required to utilize the optimum launch doctrine.

- ... Prepare the preliminary design specifications for modifications to existing surface ships' fire control systems required to implement the launch doctrine.

Arma study report of "Firing Doctrine and Fire Control Equipments for Torpedoes MK 44 Mods 1, 2, 3, 4 and MK 46 Mod 0 (DR-61-E652-18) dated 14 July 1961", recommended the use of a Launch Range Display Unit or slide rule as a mechanical aid in firing the over-the-side torpedoes.

Contract Modification 13, dated 1 September 1961, directed Arma to:

- ... Design, develop and manufacture twenty-five (25) "Simplified Torpedo Launch Range Slide Rules" as referenced in Arma report DR-61-E652-18 of 14 July 1961. (See report dated 18 August 1961.)

A preliminary study effort to determine "optimum vessel size for Terne III missile and Fire Control System" reopened the question of desirability or need for this study. The conclusion reached was that the study results would be academic in light of the development of effective over-the-side torpedoes which more than adequately covered the Terne III weapon range. NUOS concurred and by letter De2al:GHA:dsr 8510/Terne dated 18 January 1962, requested NPO Bklyn to cancel this effort from the contract.

Contract Modification 17 dated 3 April 1962, deleted the contractual requirement for the study effort to determine "optimum vessel size for Terne III missile and Fire Control System".

Design Concepts of Launch Range Display Unit and Slide Rules:

- 1) Launch Range Display Unit Description. The Launch Range Display Unit (Experimental) automatically displays launch range for runout Torpedo MK 44 Mod 1 as a function of Target Angle for either a high-speed or a low-speed target. The unit also automatically transmits a Course-to-Steer order which aids the helmsman in pointing the Torpedo Tube MK 32 at the target at the instant of firing from a surface vessel. The display unit is packaged in a reinforced sheet metal drip proof cabinet

equipped with louvers for ventilation and a stuffing-tube patch plate for ship's cable entry. The unit weighs 80 pounds. Overall case dimensions are 14 inches high, 20 1/2 inches wide, and 12 inches deep. Four shock mounts are located on the base of the cabinet.

- 2) Launch Range Display Unit, Operation. The Launch Range Display Unit (Experimental) is employed to indicate the optimum range at which two torpedoes MK 44 Mod 1 should be fired to acquire the target as a function of Target Angle. The displayed ranges are predicated on launching two torpedoes (at different depths) parallel to the Target Bearing line (based on recommendations outlined in study report "Firing Doctrine and Fire Control Equipment for Torpedoes Mk 44 Mod 1, 2, 3, 4 and Mk 46 Mod 0" - Arma Document DR-61-E652-18 dated 18 August 1961.) This requires the firing ship to maneuver as directed by a course correction order transmitted from the display unit. If target speed is slow (0 to 15 knots) effective firing may be done at a sonar range within the range band between the two black lines. If target speed is between 10 to 25 knots, effective firing may be done only at the range as displayed by the red curve.

The drum containing the launch range curves for the Torpedo MK 44 Mod 1 may be readily removed and replaced with a drum with launch range curves for any of the other over-the-side torpedoes (no additional drums were provided for under this program).

The launch range unit transmits helmsman's Course Correction orders by selecting those computed by the Attack Director MK 5 or those computed in the Launch Range Display Unit for firing Torpedo MK 44 Mod 1. To compute jCo for torpedo firing, Relative Target Bearing is modified by a synchro differential generator (SDG) whose shaft is positioned and locked to an angle equal to the train of the starboard Torpedo Tube MK 32. (It is required that both port and starboard torpedo tubes are displaced by equal angles from the bow.) To obtain the correct synchro signal for the Port Torpedo Tube, the stator and rotor leads of the SDG are reversed by the Port-Stbd switch.

- 3) Launch Range Calculators (Slide Rules), Description.
The Launch Range Calculators (Slide Rules) display torpedo launch range requirements against high or low speed targets. The slide rules are circular plastic dials which have a diameter of 8 1/2 inches. One side is used for a low-speed (0 - 15 knot) and the other side for a high-speed (10 - 15 knot) target. For high speed targets, optimum range is indicated in red and for low speed targets an optimum range band is displayed in black. Ranges are displayed by placing the slide rule index at the value of Target Angle displayed at the Attack Director MK 5 (or similar equipment) and reading the corresponding range.

Three slide rules are used, one each is required for firing a salvo of torpedoes of the following types as a function of Target Angle:

Two Torpedoes MK 44 Mod 1
Two Torpedoes MK 44 Mods 2, 3, 4
One Torpedo MK 46 Mod 0

The ASW officer will determine the torpedo type to be fired from the available complement and will select the corresponding calculator. After Target Speed has been determined, the high or low speed side of the slide rule is selected.

After comparing the desired launching range with the actual target range, the necessary helmsman's order must be generated to minimize the difference. At the moment of firing, course correction orders must be transmitted to the bridge in order to align the tube being fired with Target Bearing.

Performance: Arma study report, Use of the AN/SQA-16 (XN-1) Sonar for U. S. ASW Target Depth Determination (DG-E531-129) dated September 1961, investigated the effect of accurate target depth information on the following weapons:

- ... Over-the-side homing Torpedoes, MK 44 Mods 1, 2, 3, 4 and MK 46 Mod 0
- ... Weapon Alfa
- ... Hedge-Hog
- ... Depth Charge

The study results indicated that:

- ... Over-the-side torpedoes MK 44 Mods 1, 2, 3, 4 do not require depth information since a salvo spread in depths (two torpedoes) will give high hit probability.
- ... Weapon Alpha - hit probability is significantly improved by depth information.
- ... Hedge-Hog - hit probability can be improved with target depth information.
- ... Depth Charge - hit probability is not significantly affected by target depth information.
- ... Terne sonar depth accuracy is satisfactory for use with Weapon Alpha and Hedge-Hog.

Six copies of the above report were hand carried to NUOS on 27 September 1961, for review and approval. Twenty-five copies plus a multilith reproducible were forwarded to NUOS by Arma ltr JFMCC-A453-M239 dated 13 February 1962.

Arma study report, Firing Doctrine and Fire Control Requirements for Torpedoes MK 44 Mods 1, 2, 3, 4 and MK 46 Mod 0 (DR-61-E652-18) was formally forwarded to NUOS on 21 August 1961 via Arma ltr JFMCC-A453-C4906.

A Preliminary OrdAlt for Attack Director MK 5 Mod 3 to Permit Installation of Launch Range Display Unit (Experimental) was prepared and (10 copies and one master copy) forwarded to NUOS on DD 250 Form, Partial Shipment No. 11 dated April 1962, for formalization into a NAVWEPS ALT.

GFM Utilization: The following government furnished material was used in the manufacture of the two (2) Launch Range Display Units (Experimental) delivered under this task:

<u>Description</u>	<u>Quantity</u>
Synchro - 37TDX6-X11	2
Synchro - 15CT6a	2
Amplifier - 1625248	2

End Item Delivery: The following items were shipped to Long Beach Naval Shipyard on 31 January 1962 via DD 250 Form, Partial Shipment No. 7.

- 2 ea. Launch Range Display Unit
- 2 ea. OrdAlt kit for Attack Director MK 5 Mod 3
- 2 ea. Slide Rule and pouch for Torpedo MK 44/1
- 2 ea. Slide Rule and pouch for Torpedo MK 44/2, 3, 4
- 2 ea. Slide Rule and pouch for Torpedo MK 46/0

The following items were shipped to NUOS on 2 February 1962 via DD 250 Form, Partial Shipment No. 8.

- 23 ea. Slide Rule and pouch for Torpedo MK 44/1
- 23 ea. Slide Rule and pouch for Torpedo MK 44/2, 3, 4
- 23 ea. Slide Rule and pouch for Torpedo MK 46/0

The following items were shipped to NUOS on 3 April 1962 via DD 250 Form, Partial Shipment No. 11.

One set of Van Dyke Drawings (Mfgrs Sketches) for Launch Range Display Unit and Slide Rule for Torpedoes MK 44/1, 2, 3, 4 and MK 46/0.

Ten copies and one master copy of Test Specification for Launch Range Display Unit.

Ten copies and one master copy of Description and Operation of Launch Range Display Unit (Experimental) and Launch Range Calculators, Arma Document DG-E531-181.

The following item was shipped to NUOS on DD 250 Form, Partial Shipment No. 9, dated 1 March 1962.

25 copies and one master of Final Report - Use of AN/SQA-16 (XN-1) Sonar for U.S. ASW Target Depth Determination.

Section 4

PROGRAM PERFORMANCE

4.1 OVERALL PROGRAM SCHEDULE

This schedule had its origin in the "Phase Plan", one of the three documents prepared under Contract N140(122)69074B as reported under Pre-Contractual Effort, para. 1.2.2. The Phase Plan graphically presented the complete government scheduling program for planning procurement, installation and evaluation of the Terne III missile, fuze and system equipments. Arma proposal document A60-7 which was incorporated into the contract, contained a performance schedule based on the details of the Phase Plan, the estimated contract start date, and the availability of both ships. Changes in ship's scheduling and KV scheduling subsequent to start of contract negotiations required a change in Arma performance. A revised schedule was forwarded to NUOS by Arma letter JFMCC-A453-C6036 dated 18 October 1960. This schedule reflected the major milestones of the contract and also indicated the activities connected with the Terne Program as seen on 28 September 1960. Following the submission of the revised schedule, further changes in the milestones and the Terne Program necessitated schedule updating. Arma letter JFMCC-A453-C1122 of 28 February 1961 to NUOS and NPO Bklyn, submitted an updated schedule of the program as of 10 February 1960. This schedule included, for information purposes, milestones of other activities connected with the Terne Program. A copy of this schedule was furnished NPO Brooklyn at NUOS verbal request (telecon, L. Risko and J. F. McConnell, Arma, of 23 May 1961) by Arma letter JFMCC-A453-C3141 dated 24 May 1961. Modification 11, dated 18 August 1961 incorporated this schedule revision as the contract time of performance.

In response to NUOS letter Te2c:FWK;dsr 8510/Terne of 16 August 1962 to Arma requesting status of the program, Arma letter JA-A453-C8303 of 25 October 1962, provided information that the remaining tasks scheduled for completion were Items 7, 8, 10, and the Final Report. The estimated dates for completion were:

Item 7. Norwegian equipment documentation - Week of 1 January 1963.

Item 7.i Fuze Test Equipment I. B. - awaiting information from KV and NUOS

Item 8 System Documentation - Week of 4 March 1963

Item 10 Engineering Services - first quarter of 1963,
pending satisfaction of any and all contractual
requirements to be stipulated by NUOS

Final Report - First quarter of 1963 pending completion of
Item 8 and as completion of Item 10 may
affect the Final Report.

NUOS letter Te3-T:FWK:pe4280 of 3 December 1962 to NPO,
Brooklyn, requested modification of the contract to reflect scheduled
dates of delivery for the above designated documentation. Modification
20, dated 7 January 1963, was issued to reflect this change in schedule.
However, Modification 20 established the date of 15 March 1963 for com-
pletion of the instruction book for Fuze Test Equipment (Item 7.i). Arma
letter JA-A453-C131 of 7 January 1963, took exception to this date in
view of the comments in the Arma letter of 25 October 1962, previously
referenced. Accordingly, Modification 21, dated 26 February 1963,
was issued to correct Modification 20 - stating that the "delivery date
for Item 7.i to be as mutually agreed upon when work on this item is
started." NUOS letter Te3:FWK:dsr;8510/Terne of 8 April 1963 deleted
the requirement for the preparation of Item 7.i from the subject con-
tract.

The Chart Program Performance, Figure 4-1, is the final
program schedule revised to show completion of each contract item.

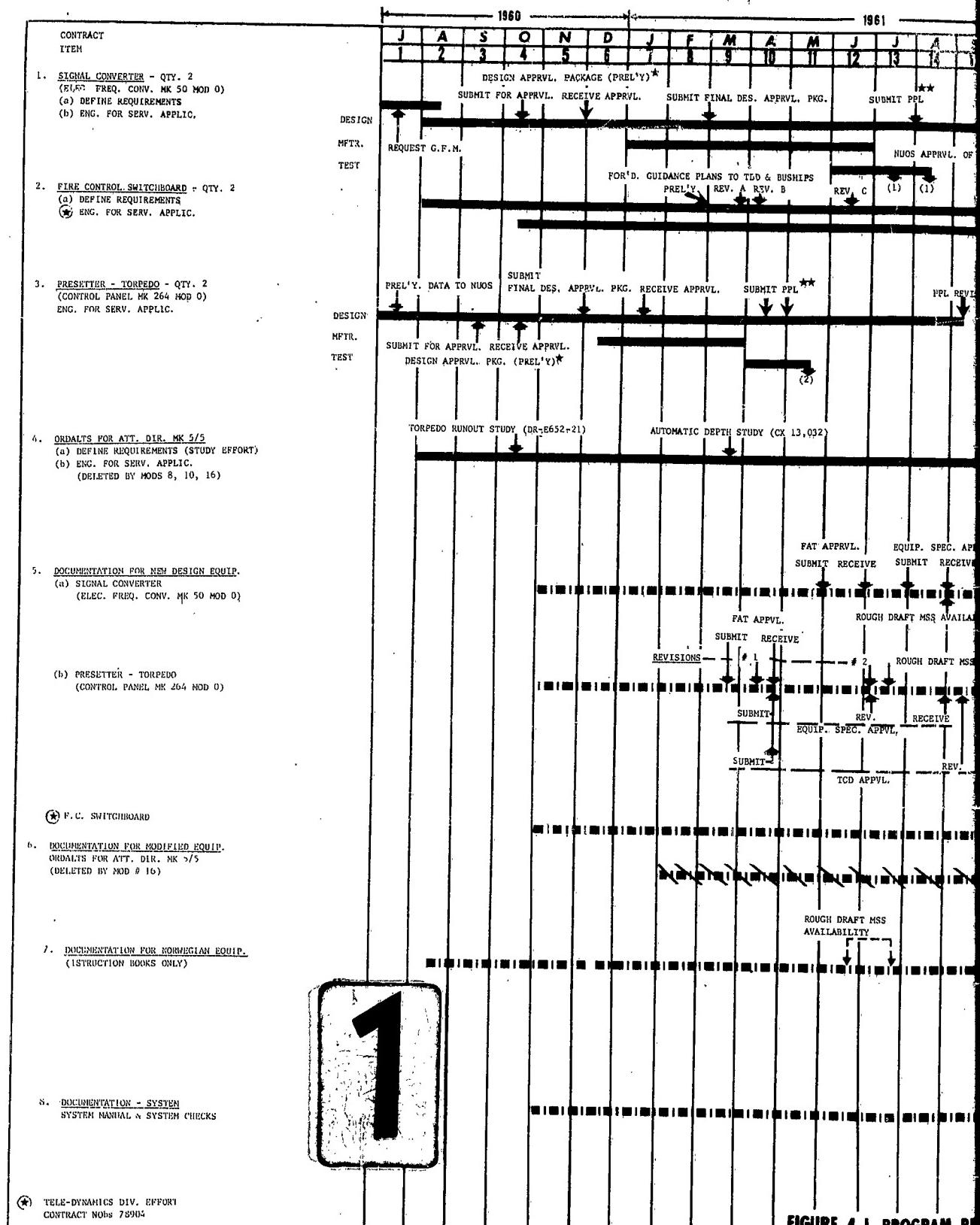
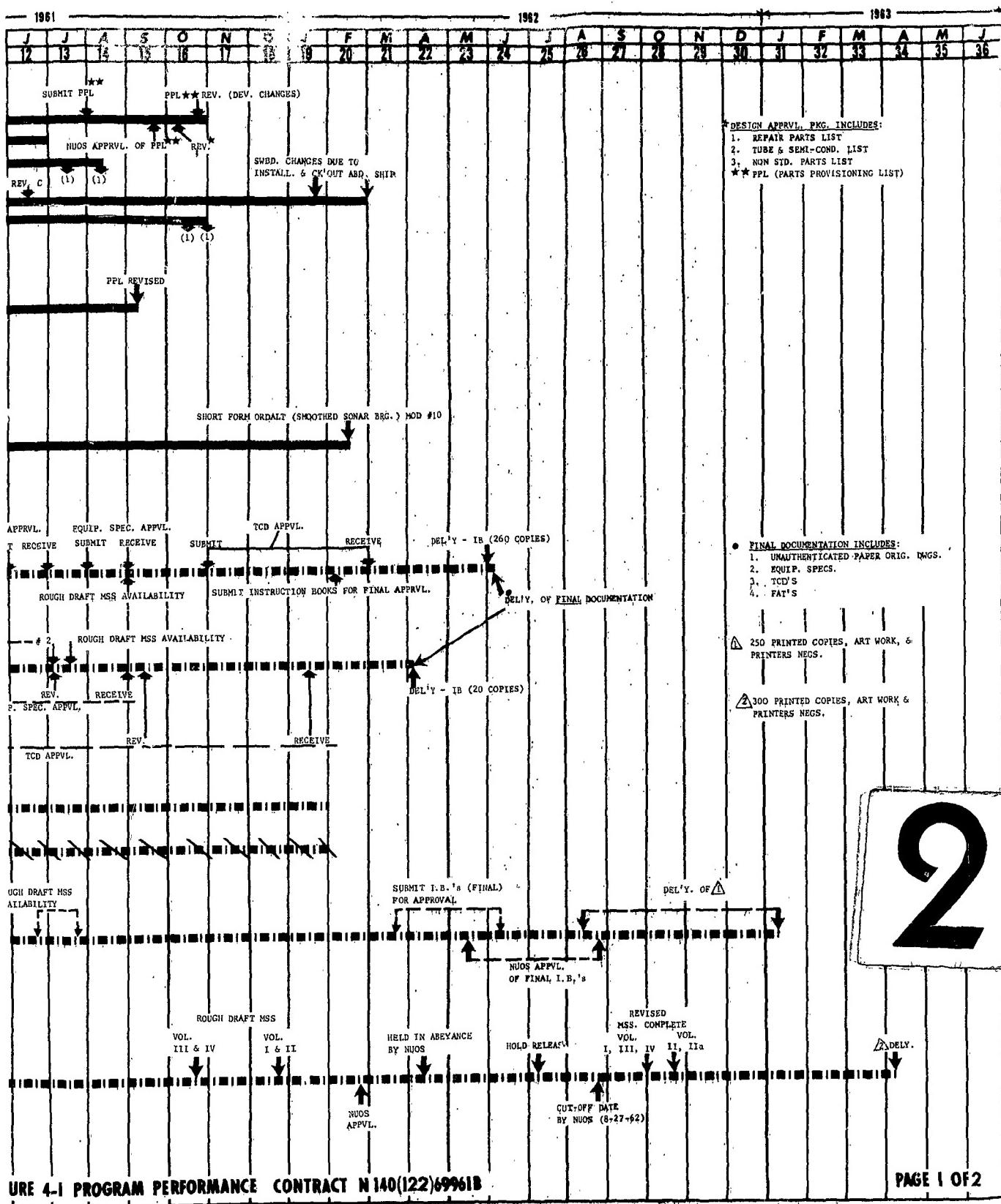


FIGURE 4-1 PROGRAM P



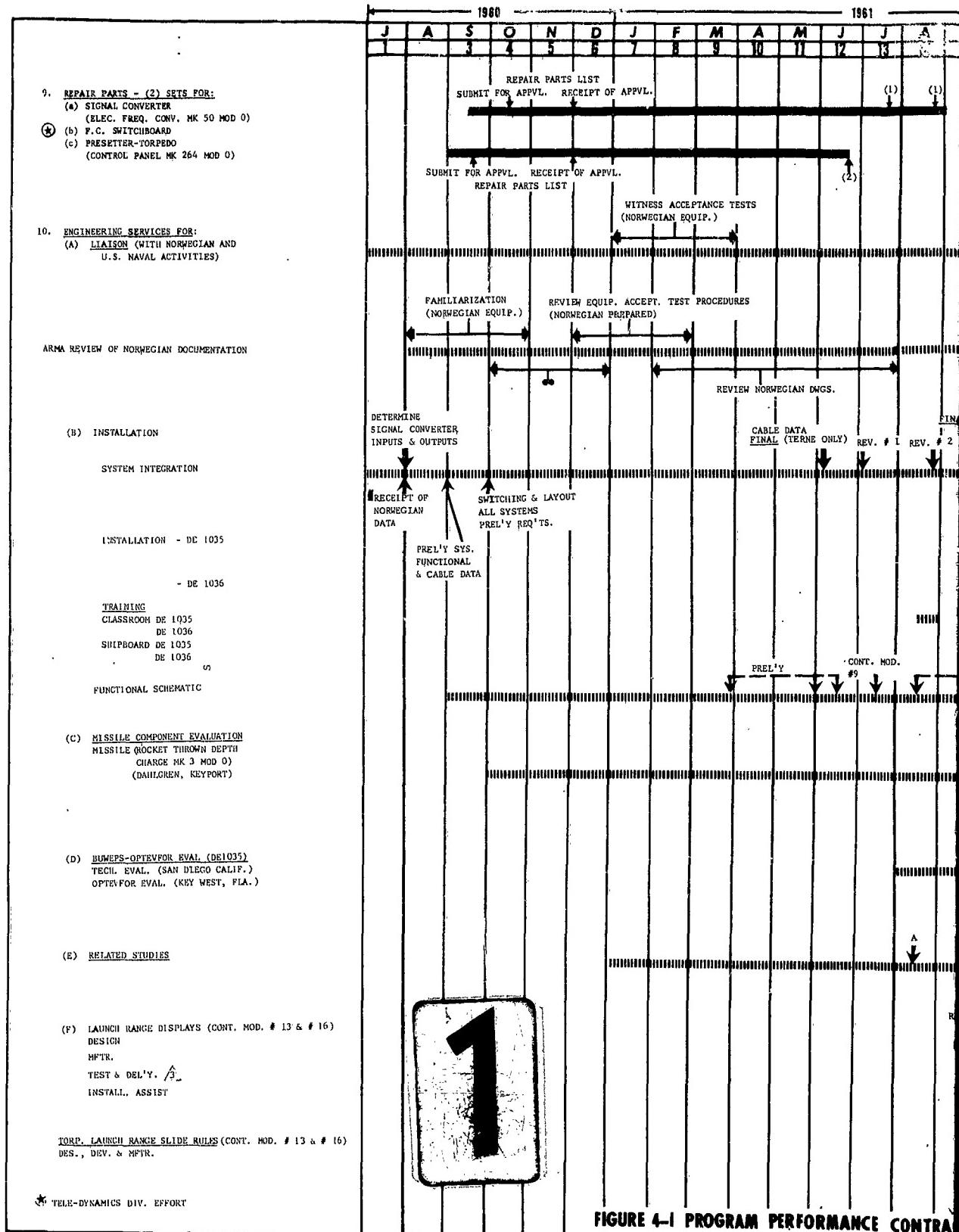
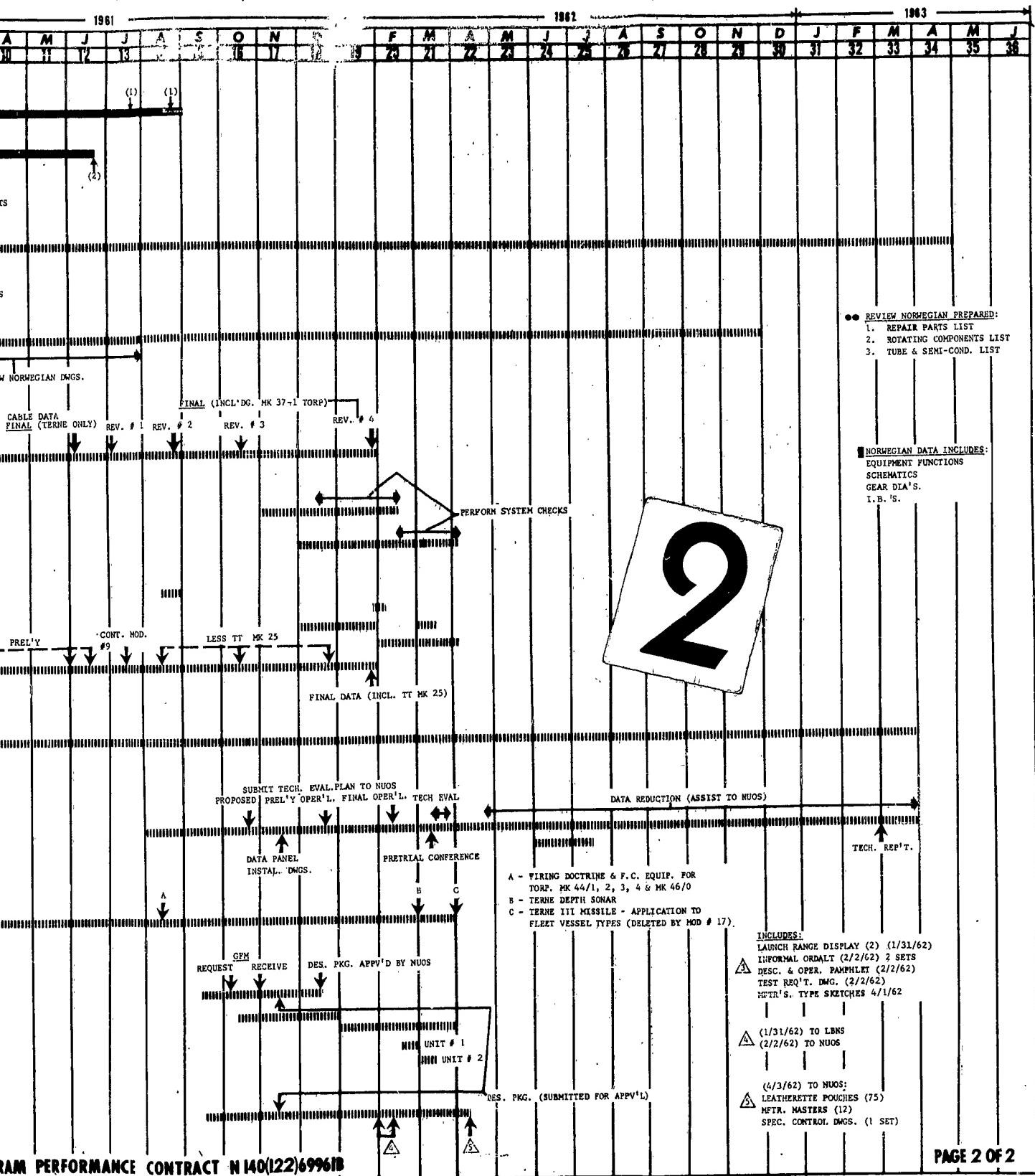


FIGURE 4-1 PROGRAM PERFORMANCE CONTRA



4.4 PROGRAM CONTROL

As can be seen from Figure 4-22, administrative control of the program was centered in Engineering Operations, with full responsibility for program planning, scheduling manning and budgetary logistics vested in the Naval Projects Section. The devices shown on this chart are representative of the controls used to assure efficient performance and accomplishment.

4.5 PROGRAM PERSONNEL

Under the Naval Projects leadership of Mr. E. R. Behn, the Arma program team responsibilities were as follows:

F. J. Romano - Development: System Integration and Analysis
New design equipment
Specifications
FATS

K. R. Mack - Installation: Equipment Integration and Cabling
Switchboard Requirements
Shipboard Installation and
Checkout
System Documentation (System
Manual and Functional Schematics)
BUWEPS Evaluation

D. R. Steen - Missile and Missile Component Evaluation

J. A. Bradford - Documentation: Instruction Books (Norwegian
Equipment)
Instruction Books (Converter and
Torpedo Presetter)
Training
Final Report

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MADE IN A
10% PIG PAPER.

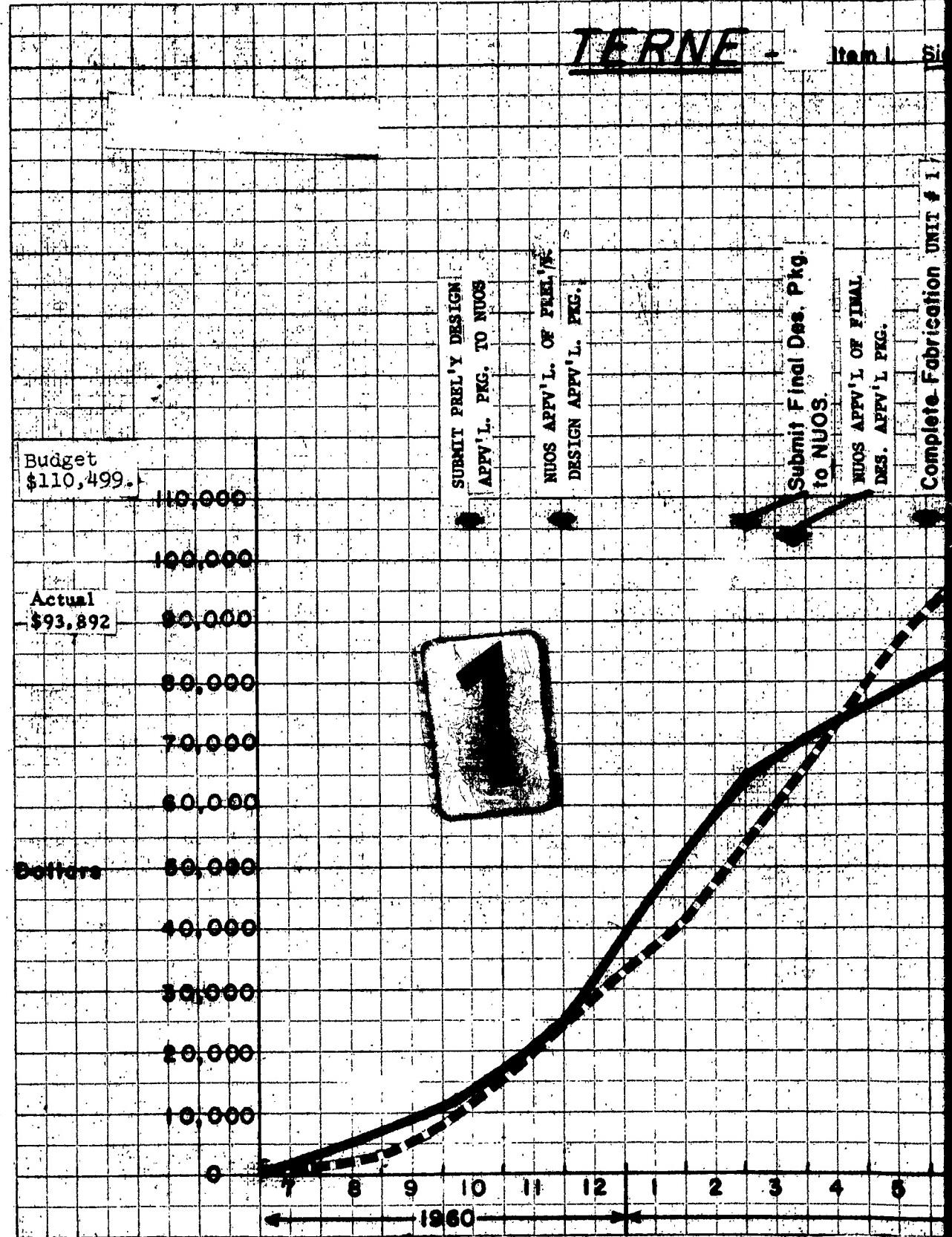
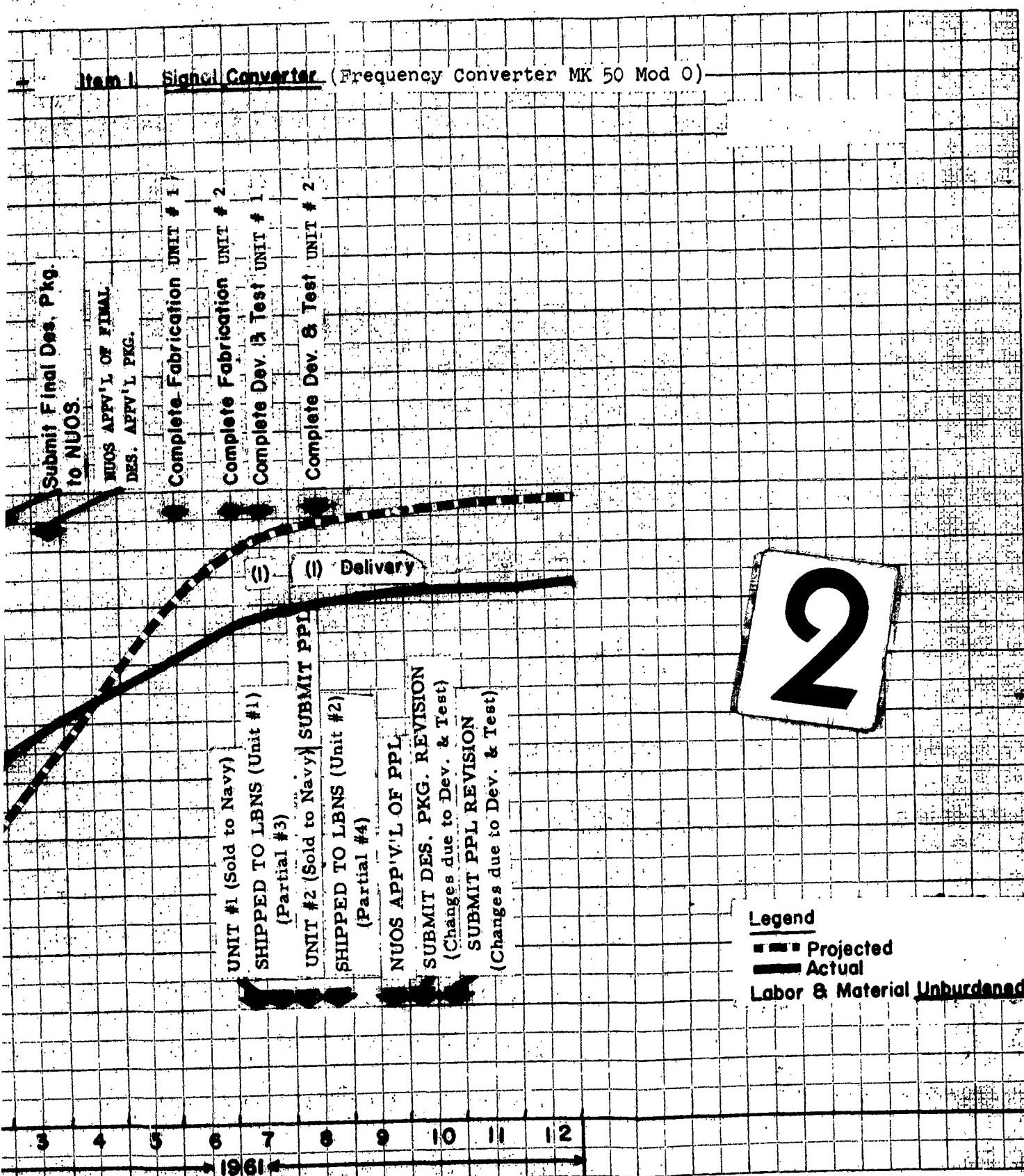


FIGURE 4.2 CONTRACT ITEM #1

Item 1. Signal Converter (Frequency Converter MK 50 Mod 0)



~~TERNE~~

Item 2. Fin

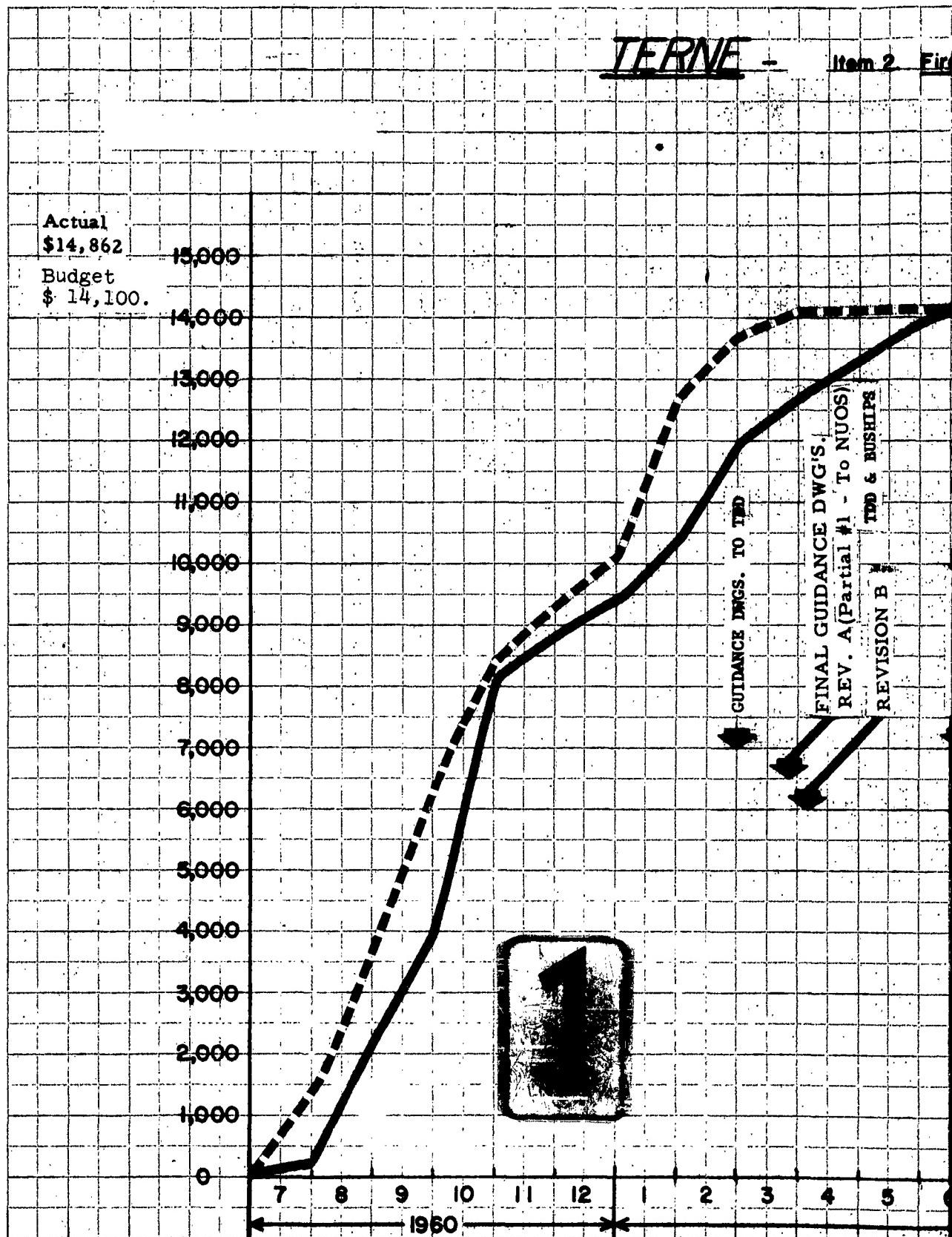


FIGURE 4.3 CONTRACT ITEM E

Item 2 Fire Control Switchboard

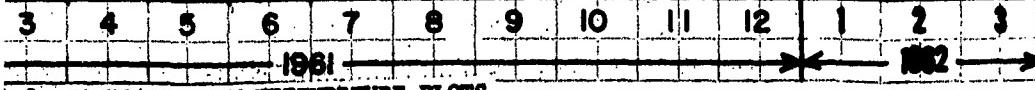
FINAL GUIDANCE DWGS
 REV. A (Partial #1 - To NUOS)
 TTD & BUSHIPS
 REVISION B
 REVISION C

SWB'D. CHANGES (DUE TO INSTAL.
 & CKOUT.) (DG-E531-179 to TD)
 FINAL SWB'D. INSTAL. CHANGES
 (DG-E531-194 to TD)

2

Legend

- Projected
- Actual

Labor & Material Unburdened

ENCL: NO 234-5 10 X 10 TIME WASH INCH.
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MILITARY AIRCRAFT
INDUSTRIAL CENTER

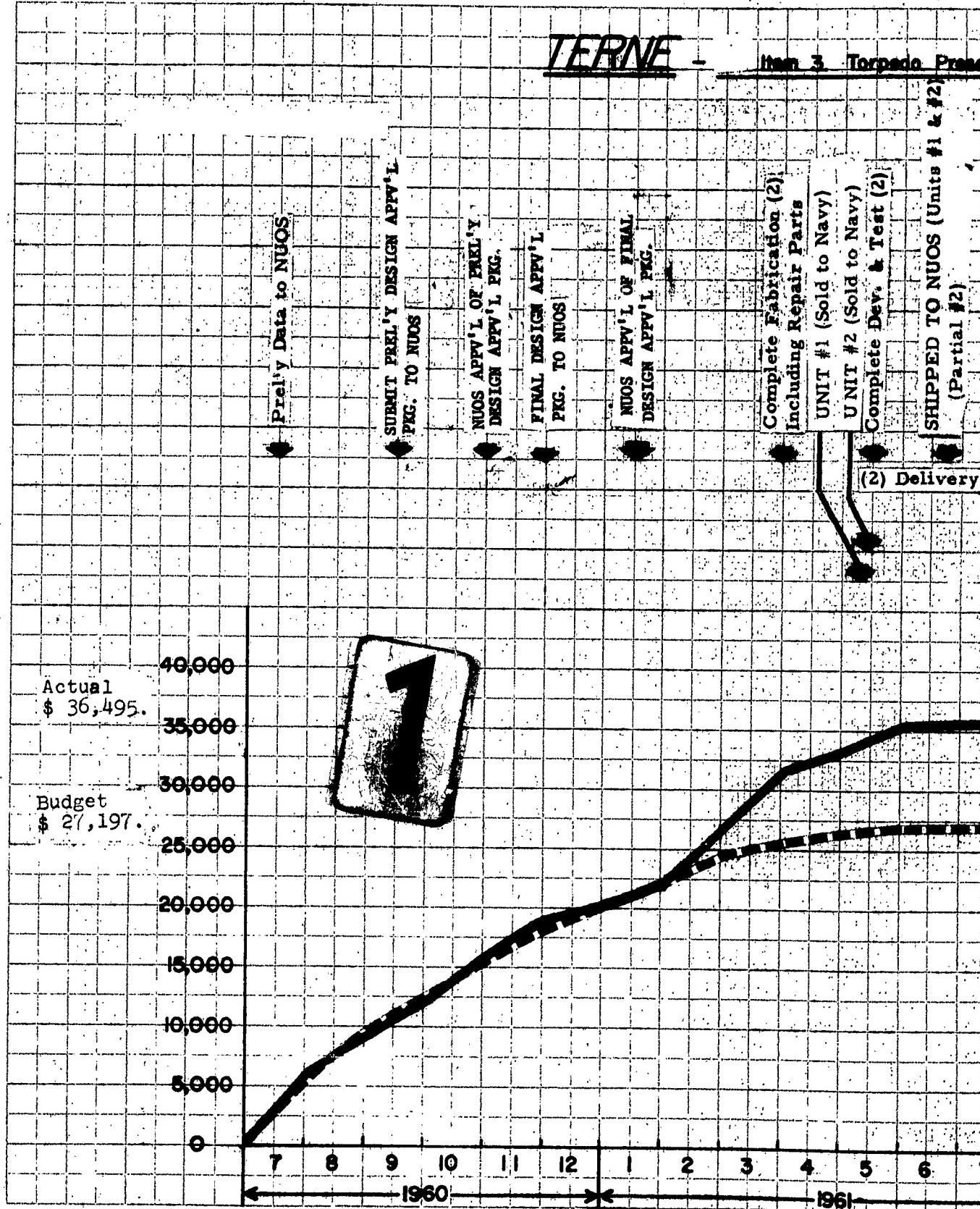


FIGURE 4.4 CONTRACT ITEM EXPENDITURE P1

Item 3. Torpedo Presetter (Control Panel MK 264 Mod 0)

Complete Fabrication (2)

Including Repair Parts

UNIT #1 (Sold to Navy)

UNIT #2 (Sold to Navy)

Complete Dev. & Test (2)

SHIPPED TO NUOS (Units #1 & #2)
(Partial #2)

(2) Delivery

12

Legend

■ Projected

— Actual

Labor & Material Unburdened

3 4 5 6 7 8

1961

CONTRACT ITEM EXPENDITURE PLOTS

KUFFEL & ESSER CO., N.Y.

93

TERNE

Item 4

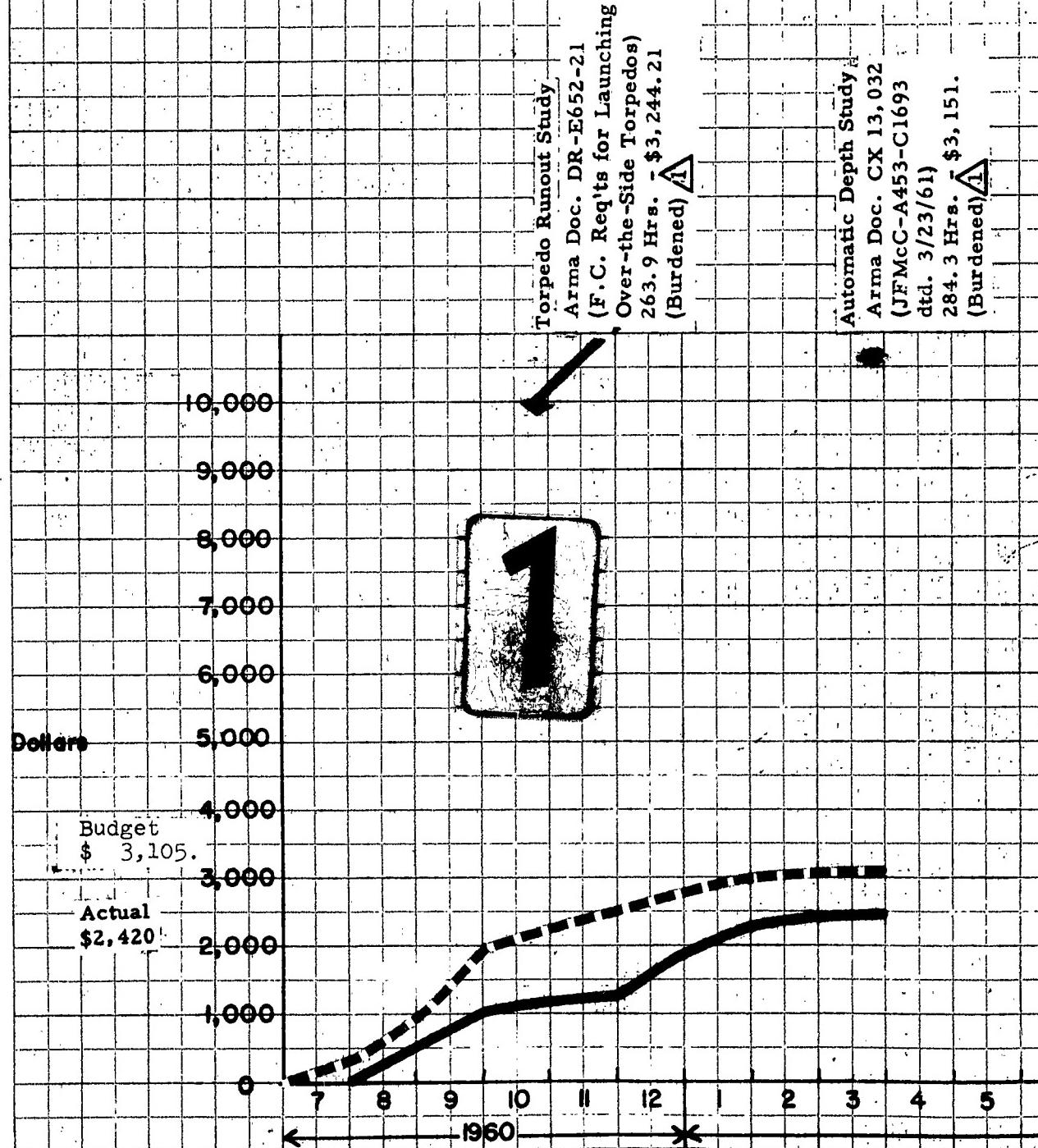


FIGURE 4.5 CONTRACT ITEM EXPENDITURE

Automatic Depth Study

Arma Doc. CX 13, 032

(JFMCC-A453-C1693

dtd. 3/23/61)

284.3 Hrs. \$3,151.

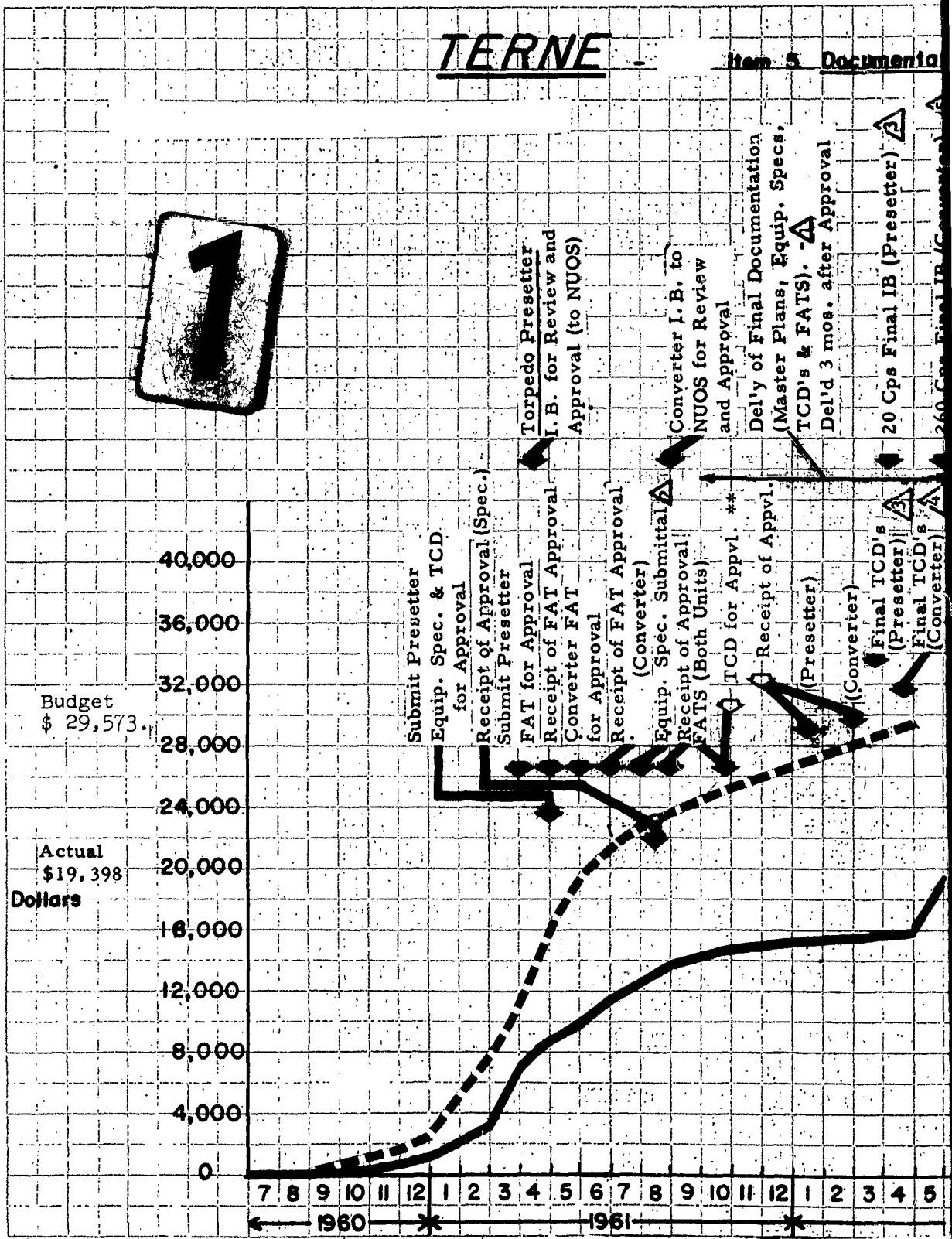
(Burdened) **A**Item 4. Ordalt Attack Director MK 5

SHORT FORM ORDALT - To NUOS
(Generated Sonar Range)

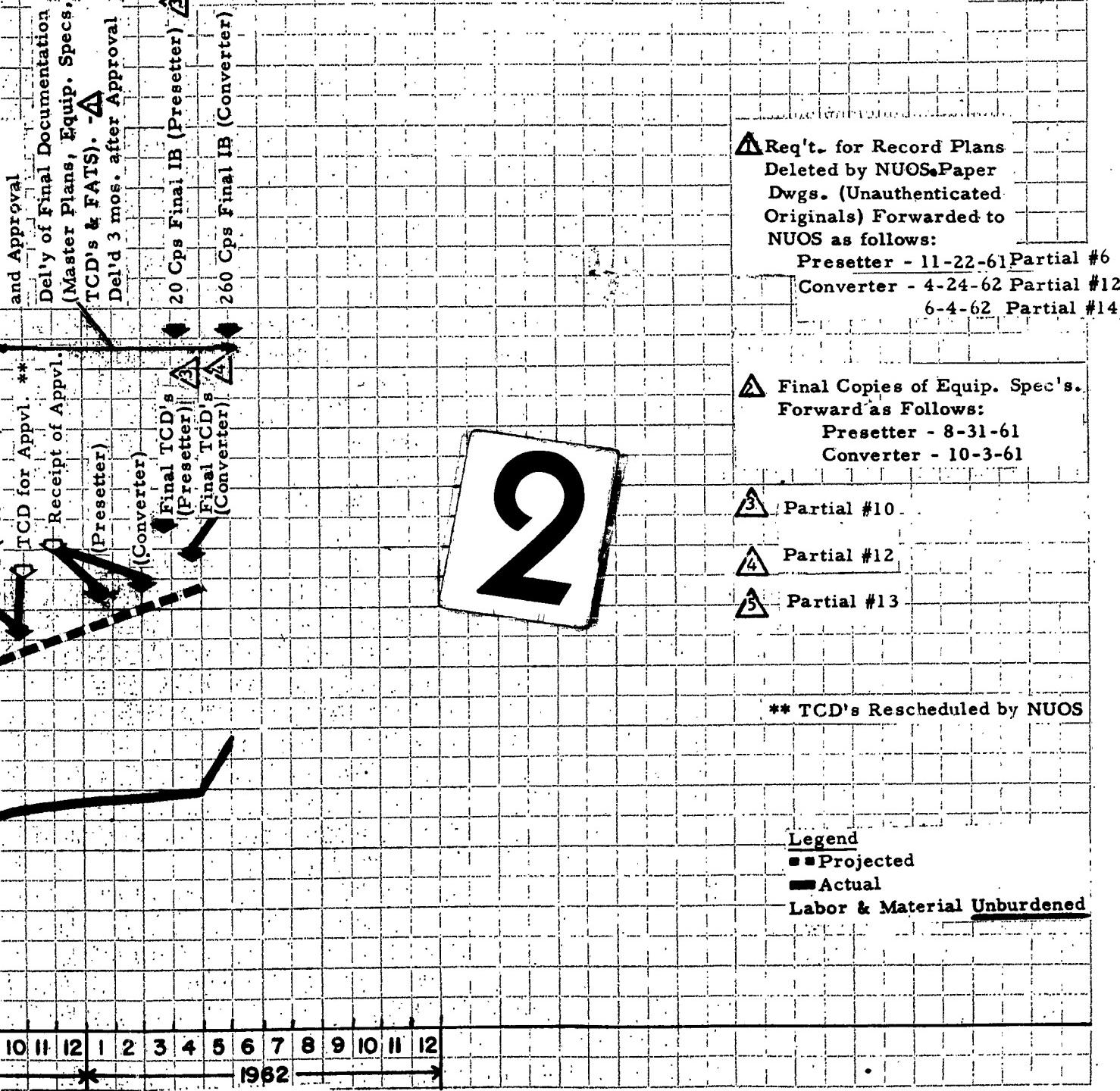
Legend**■ Projected****— Actual****Labor & Material Unburdened****(SEE Partial #5)****2**

2 3 4 5 6 7 8 9 10 11 12 13

1961



Item 5 Documentation Signal Converter & Torpedo Presetter



TERNE

Item 7 Documentation

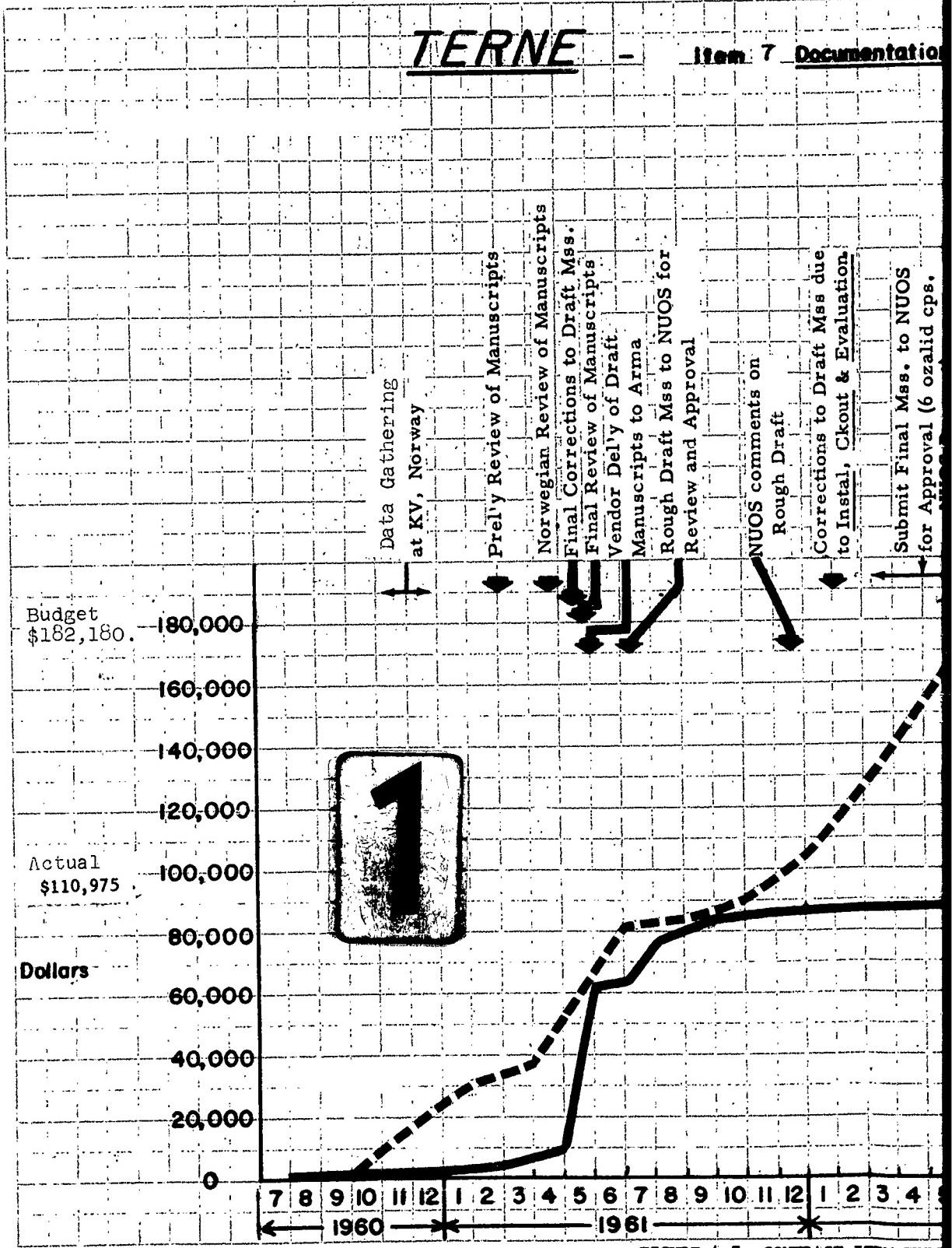


FIGURE 4.7 CONTRACT ITEM EXPENSES

IN 7 Documentation - Norwegian Equipment

NUOS comments on
Rough Draft
Corrections to Draft Mass due
to Instal, Ckout & Evaluation

Submit Final Mass. to NUOS
for Approval (6 ozalid cps.
per NUOS Request)

NUOS APPVL. OF FINAL MASS

8-27-62 Cut-Off Date Per
NUOS ltr. Dated 8-22-62

Delivery of 1 Set Printers Neg's.
and 250 Printed copies to
NUOS

PARTIAL #

NAWWEPS OP'S DESCRIPTION

3036	Dud. Jett. Rkt.	15
3031	Pos. Ind.	16
3032	Fir. Panel	16
3037	Pwr. Dist. Panel	16
3030	Analog Computer	17
3033	Rkt. Thrown Depth Chg.	18
3034	Launcher Ldg. House	19
NAVSHPHS	SONAR Bks.	19
94181		

2

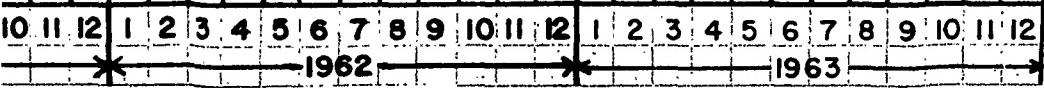
INCREASE IN SCOPE OF VENDOR EFFORTS
NOT YET NEGOTIATED BUT EXPECTED TO
MAKE THIS DIFFERENCE NEGLIGIBLE

Legend

■ Projected

— Actual

Labor & Material Unburdened



TERNE

Item 8 SW

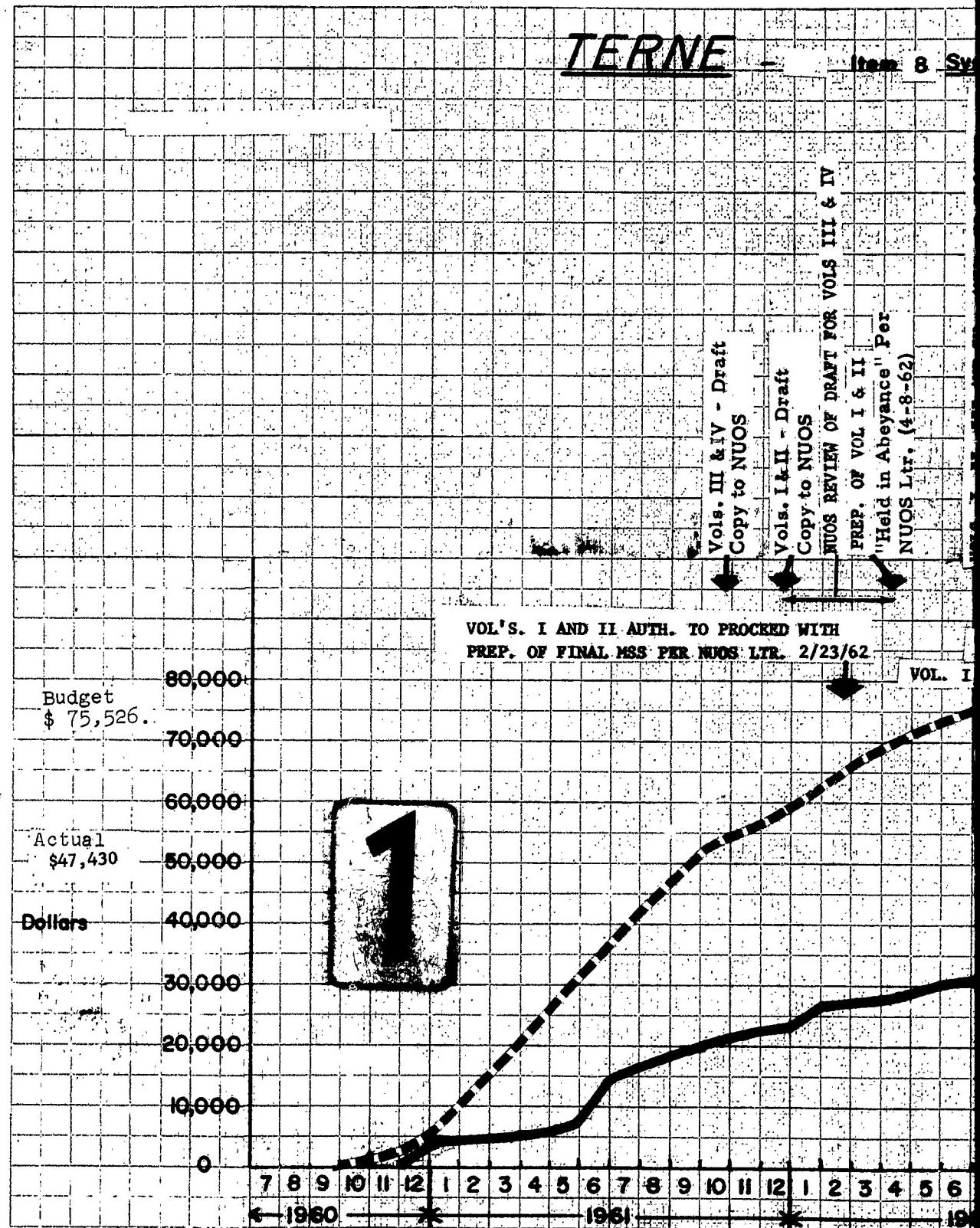
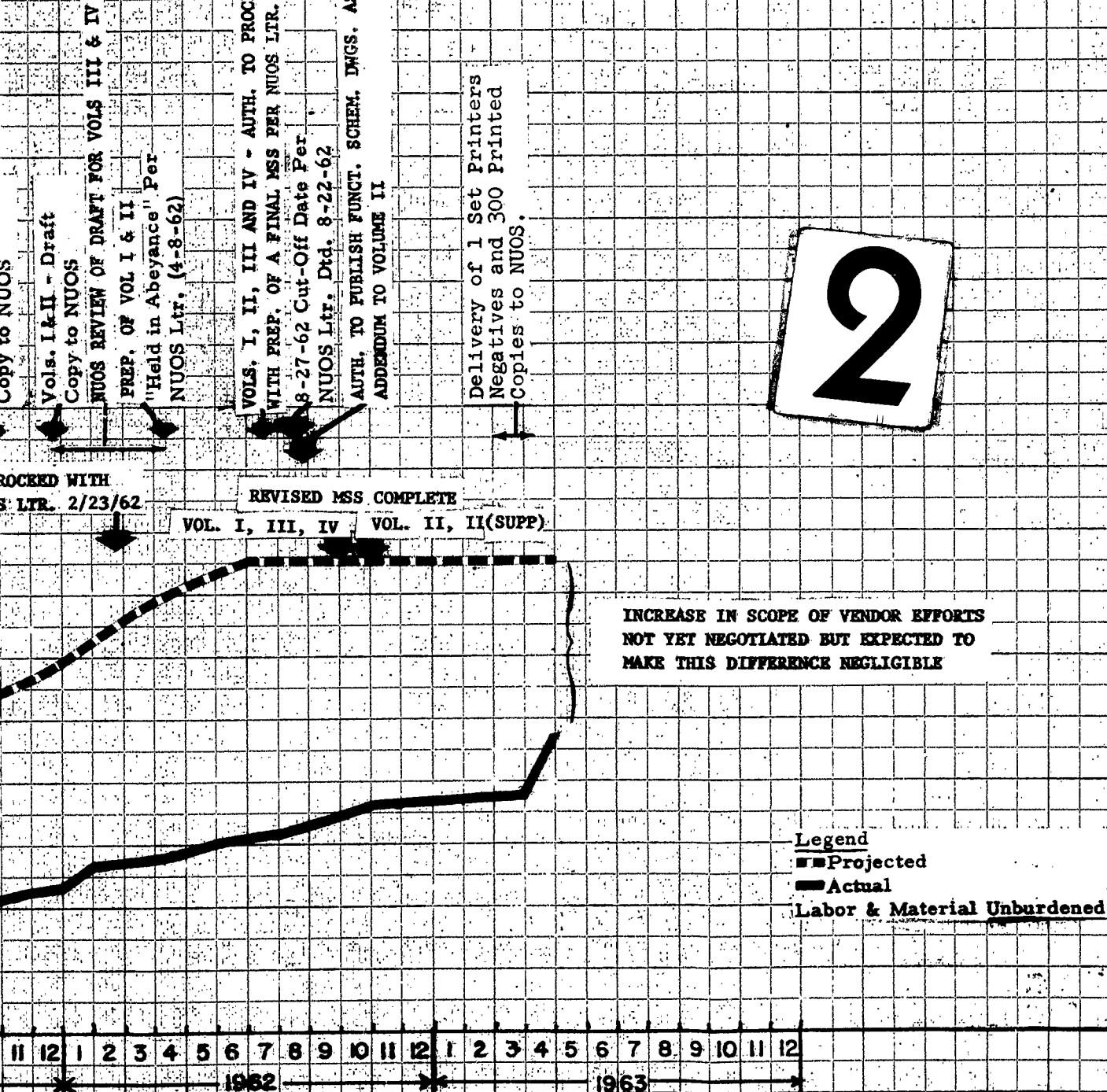


FIGURE 4.8 CONTRACT ITEM EXPENDITURE

**Item 8 System Documentation NAVWEPS OD 15104 ASW WEAPON SYSTEM MK 1 MOD 0 VOL'S. I, II AND
SUPPLEMENT, III AND IV**



TERNE

Item 9 Report

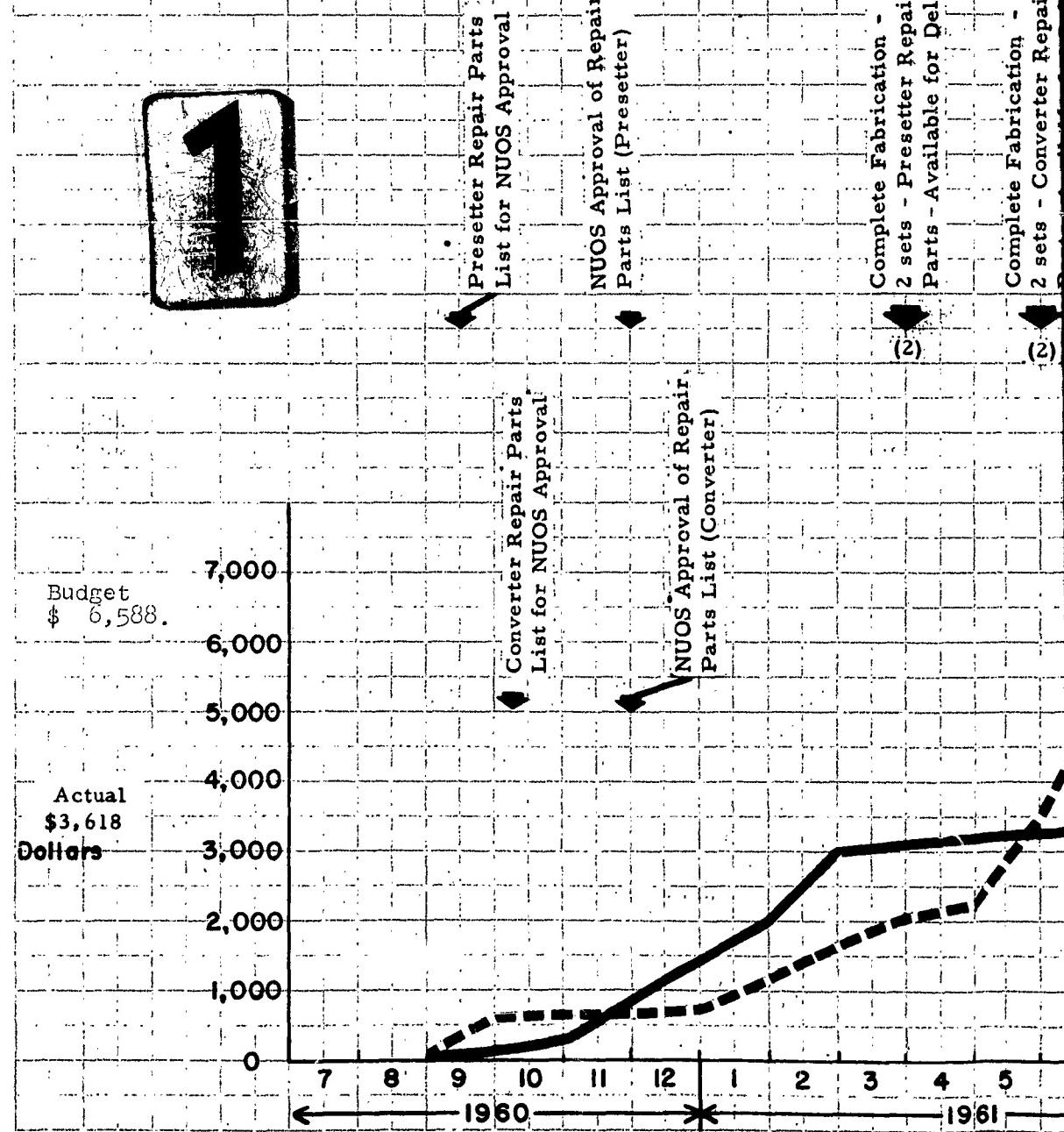


FIGURE 4.9 CONTRACT ITEM EXPENDITURE

Item 9 Repair Parts for Converter & Presetter

Complete Fabrication -

2 sets - Presetter Repair
Parts - Available for Del'Y.Complete Fabrication -
2 sets - Converter Repair
Parts - Available for Del'Y.SHIPPED TO NUOS
(Presetter - 2 Sets - Partial #2)

SHIPPED TO LBNS

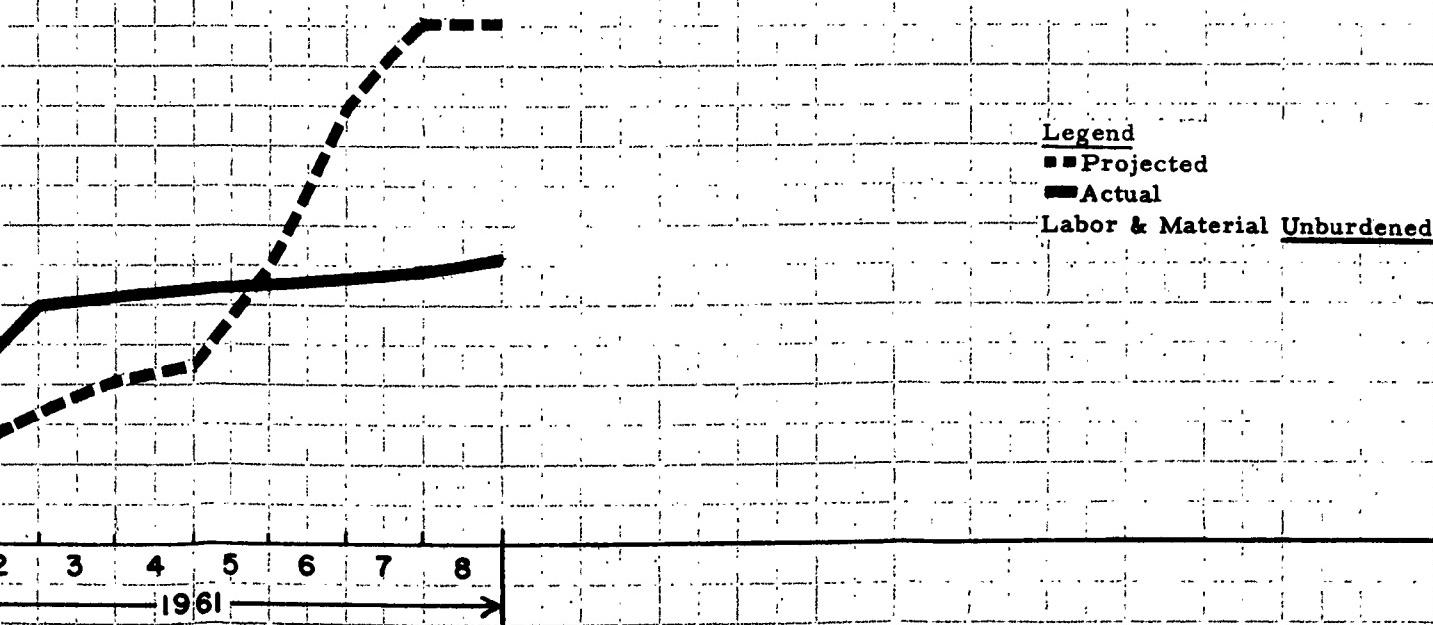
(Converter - 1st Set - Partial #3)

SHIPPED TO LBNS

(Converter - 2nd Set - Partial #4)

**Legend**

- ■ Projected
- Actual

Labor & Material Unburdened

~~TERNE~~

Item 10A E

~~Overall Program Liaison with
Norwegian & U.S. Naval Activities~~

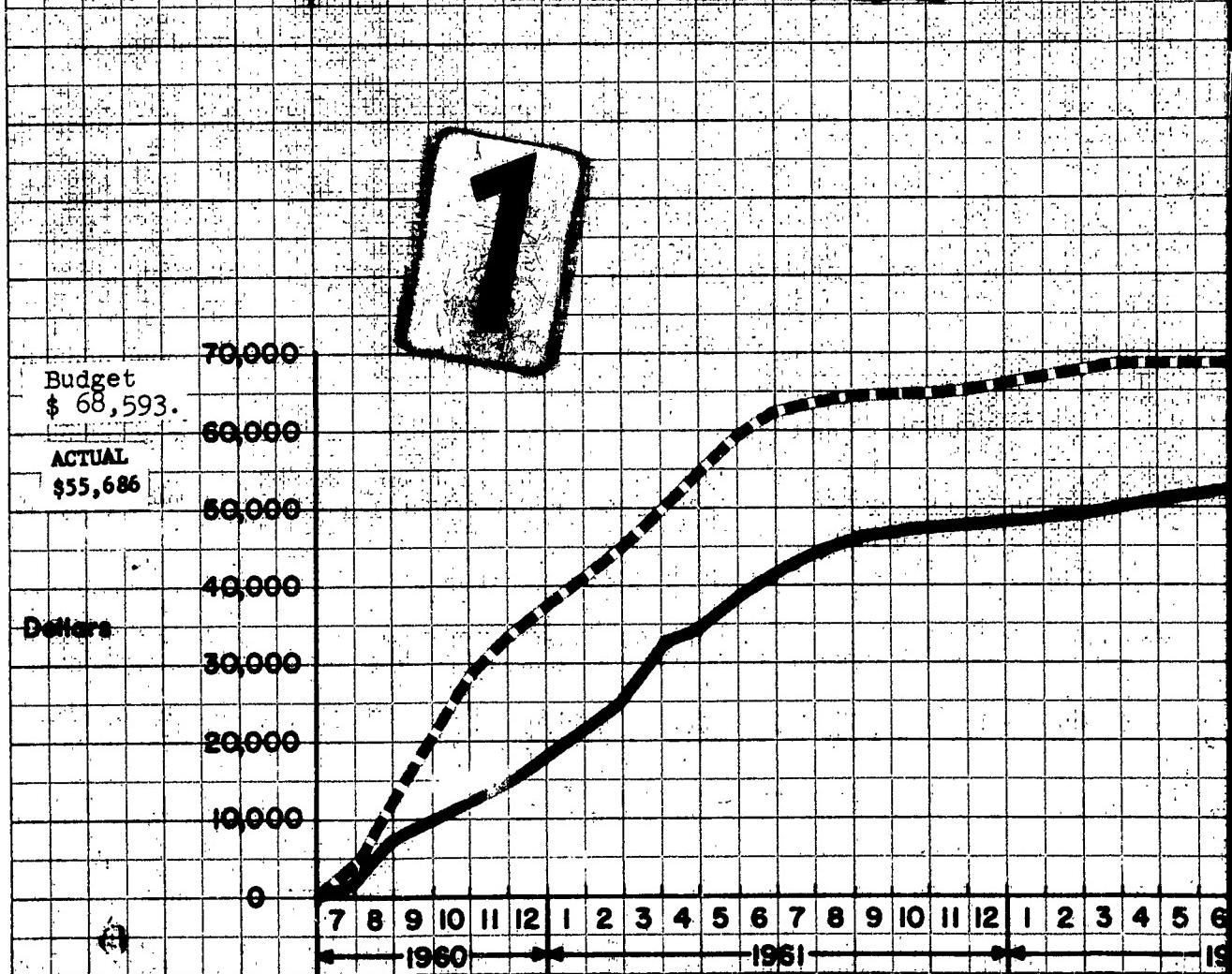


FIGURE 4.10 CONTRACT ITEM EXPENDITURE

Item 10A Engineering Services - Liaison

2

Legend
■ Projected
— Actual
Labor & Material Unburdened

0	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
0	1	2	3	4	5	6	7	8	9	10	11	12	0	1	2	3	4	5	6	7	8	9	10	11

1952

1963

10 CONTRACT ITEM EXPENDITURE PLOTS

KEUFFEL & ESSER CO. N.Y.

TERNE

Part of: Item 10B Engineering

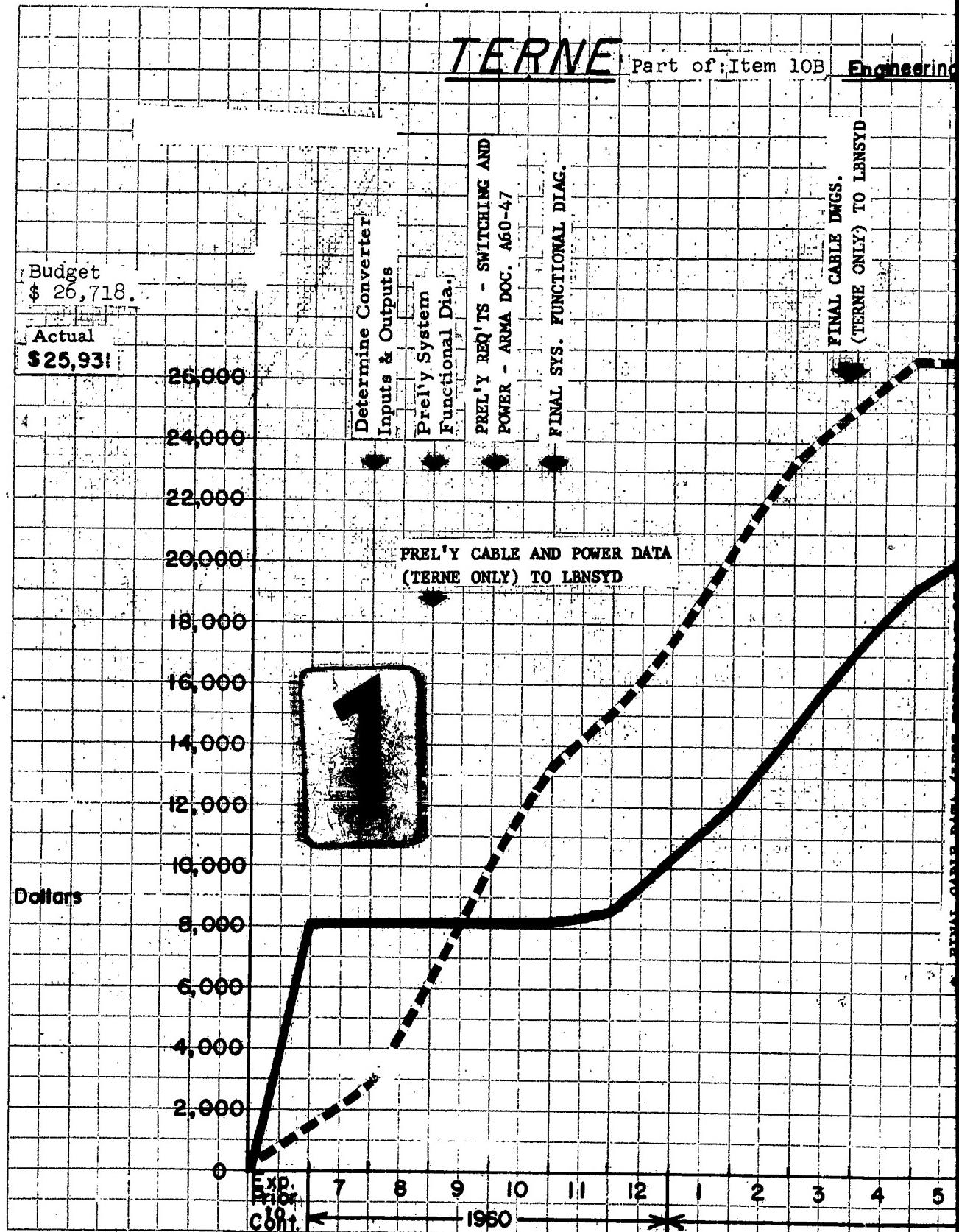
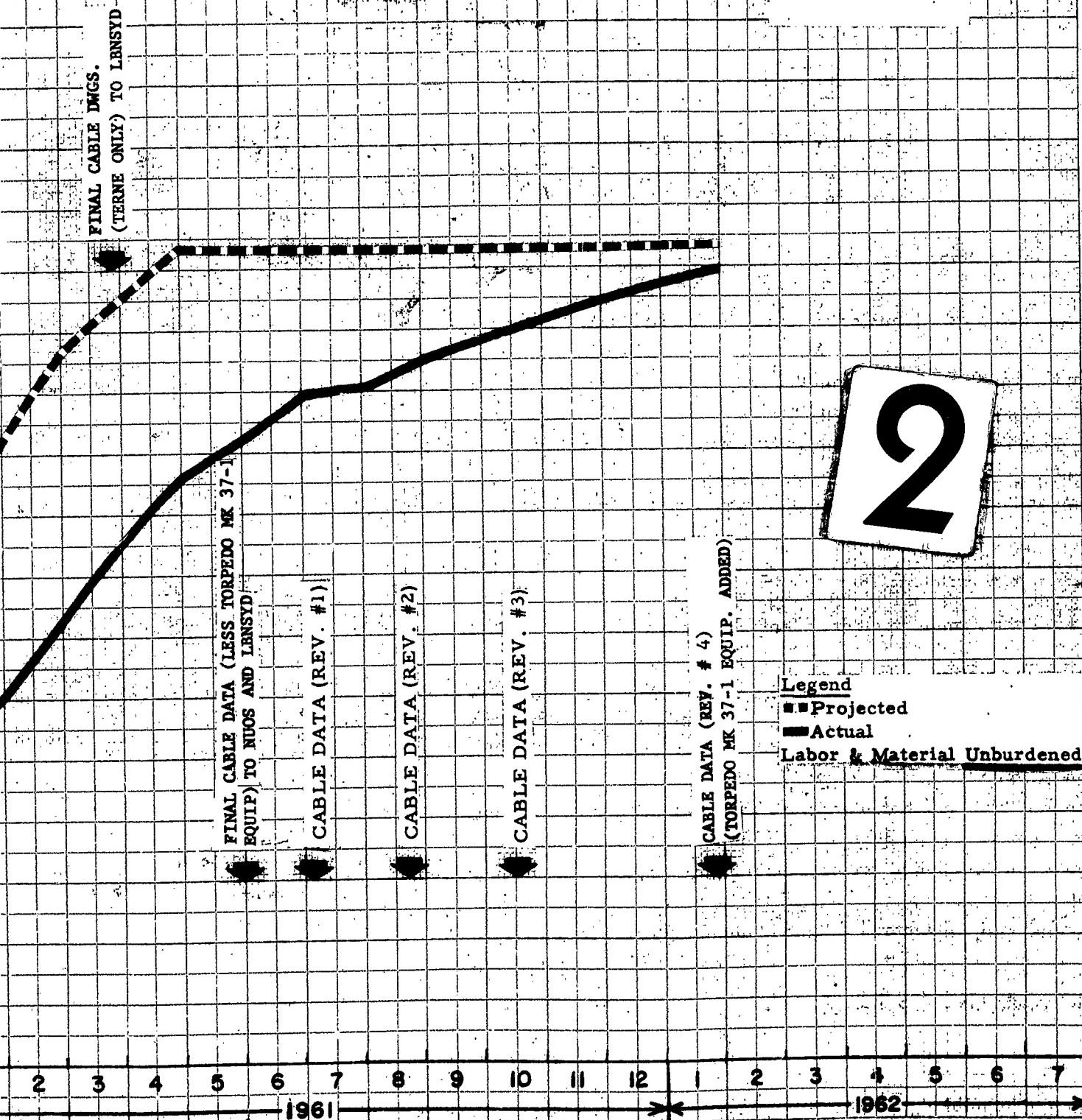


FIGURE 4.11 CONTRACT ITEM EXPEND

Item 10B Engineering Services - Installation (System Integration & Analysis)

TERNE

Part of: Item 10B Engineer

Budget
\$ 42,643.

Actual
\$42,211

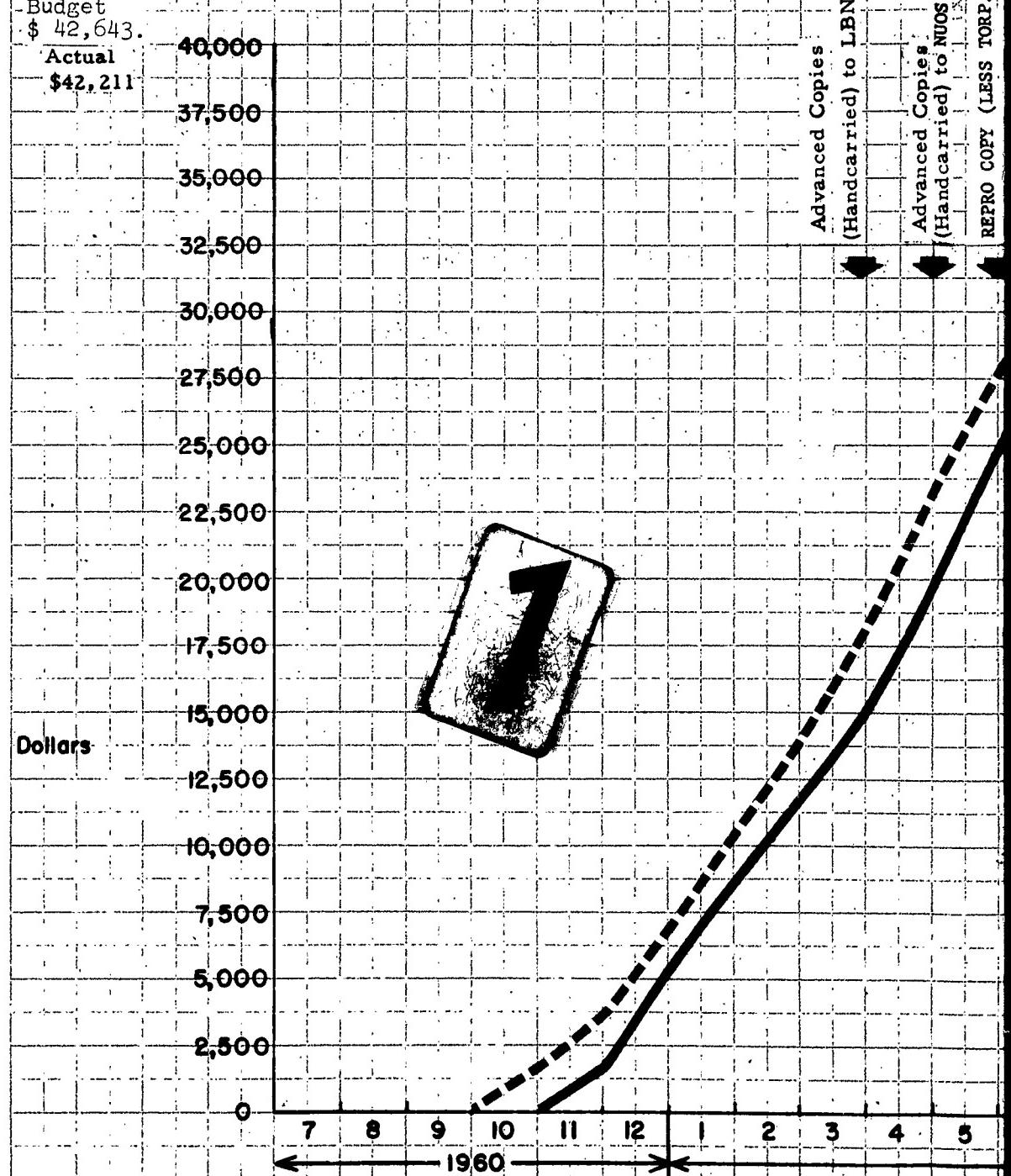
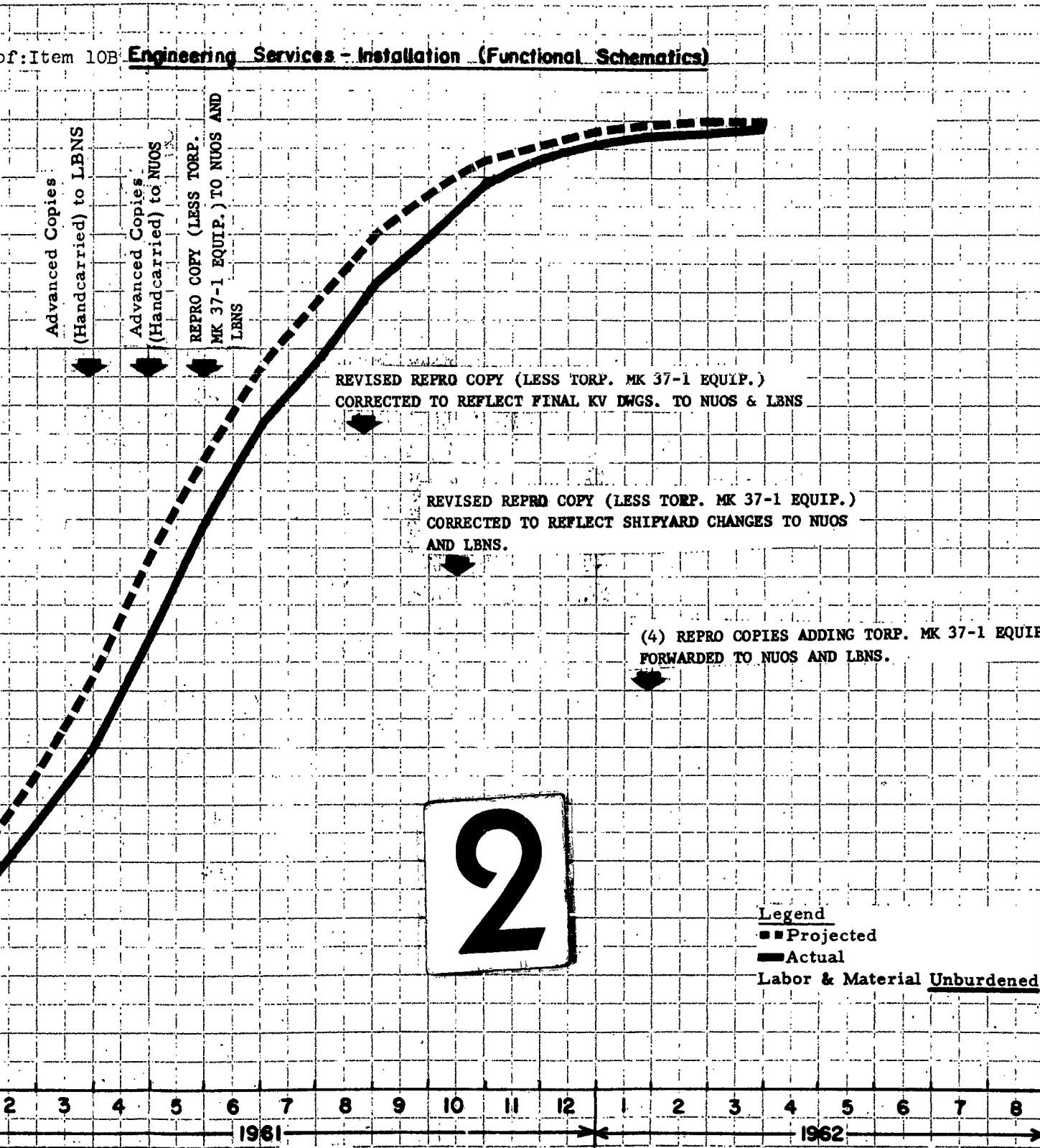


FIGURE 4.12 CONTRACT ITEM EX

of:Item 10B Engineering Services - Installation (Functional Schematics)

~~TERNE~~ Part of: Item 10B Engin

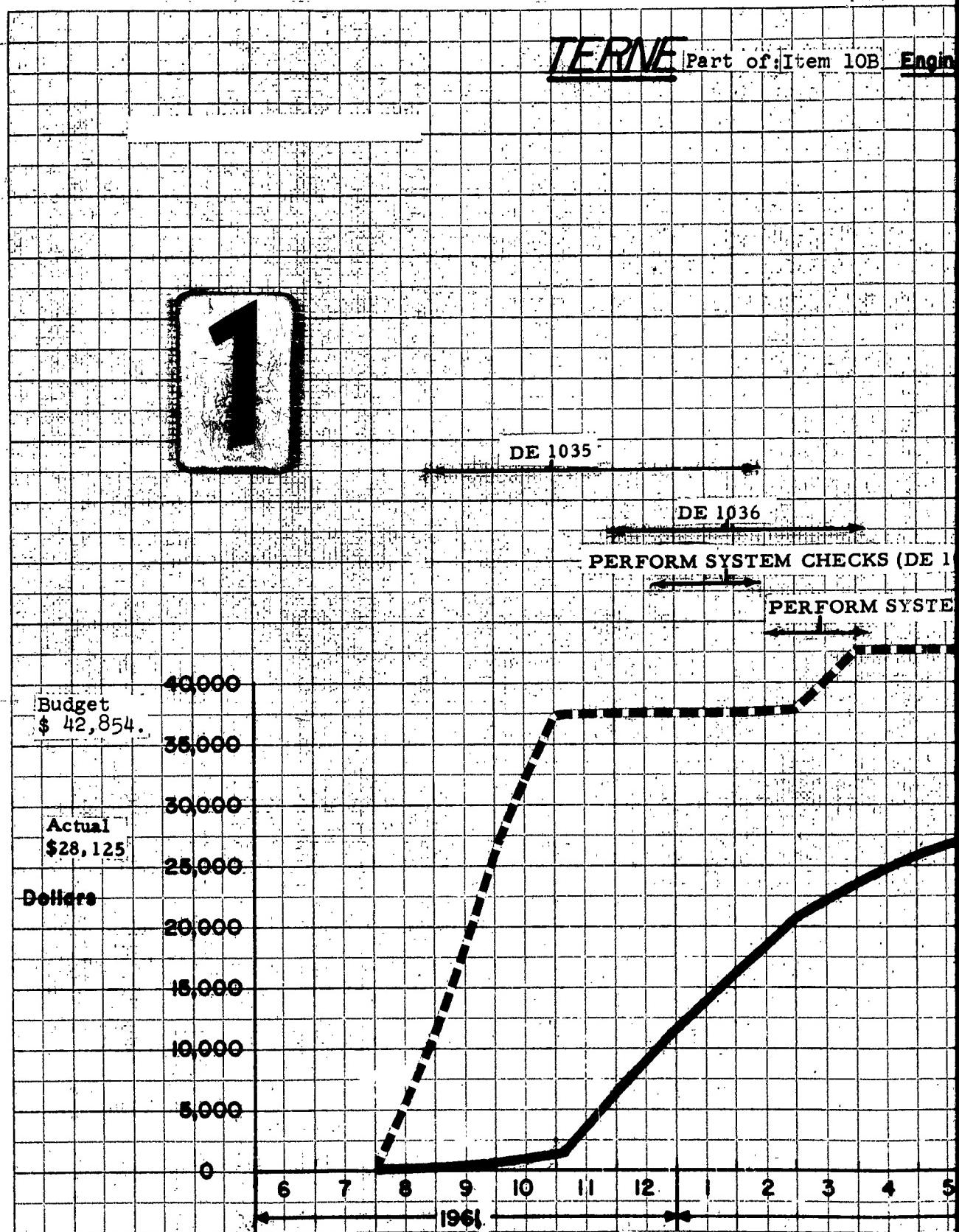


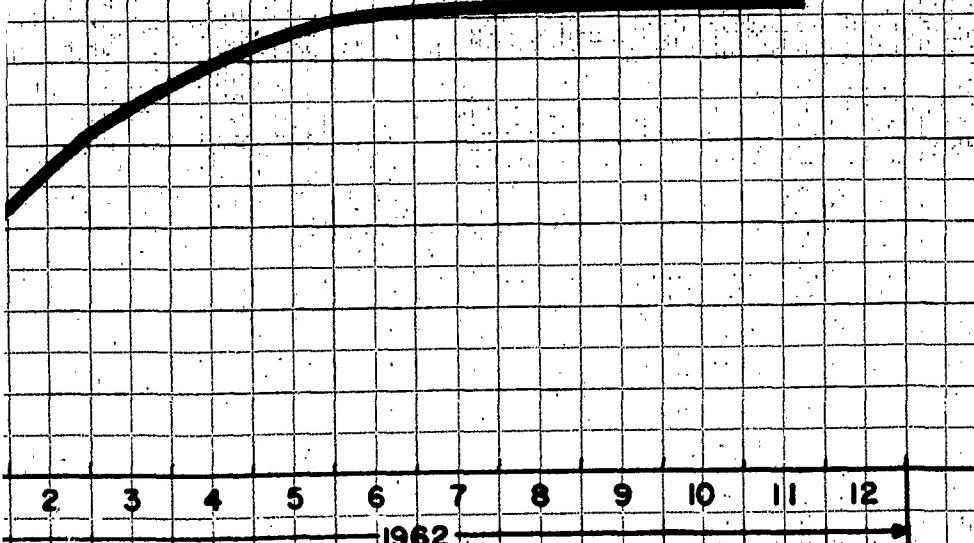
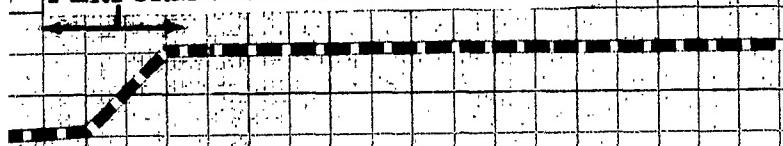
FIGURE 4.13 CONTRACT ITEM EXPENSE

of: Item 10B Engineering Services - Installation & Checkout

36

ITEM CHECKS (DE 1035)

PERFORM SYSTEM CHECKS (DE 1036)



Legend

- Projected
- Actual

Labor & Material Unburdened

2 3 4 5 6 7 8 9 10 11 12
1962

13. CONTRACT ITEM EXPENDITURE PLOTS

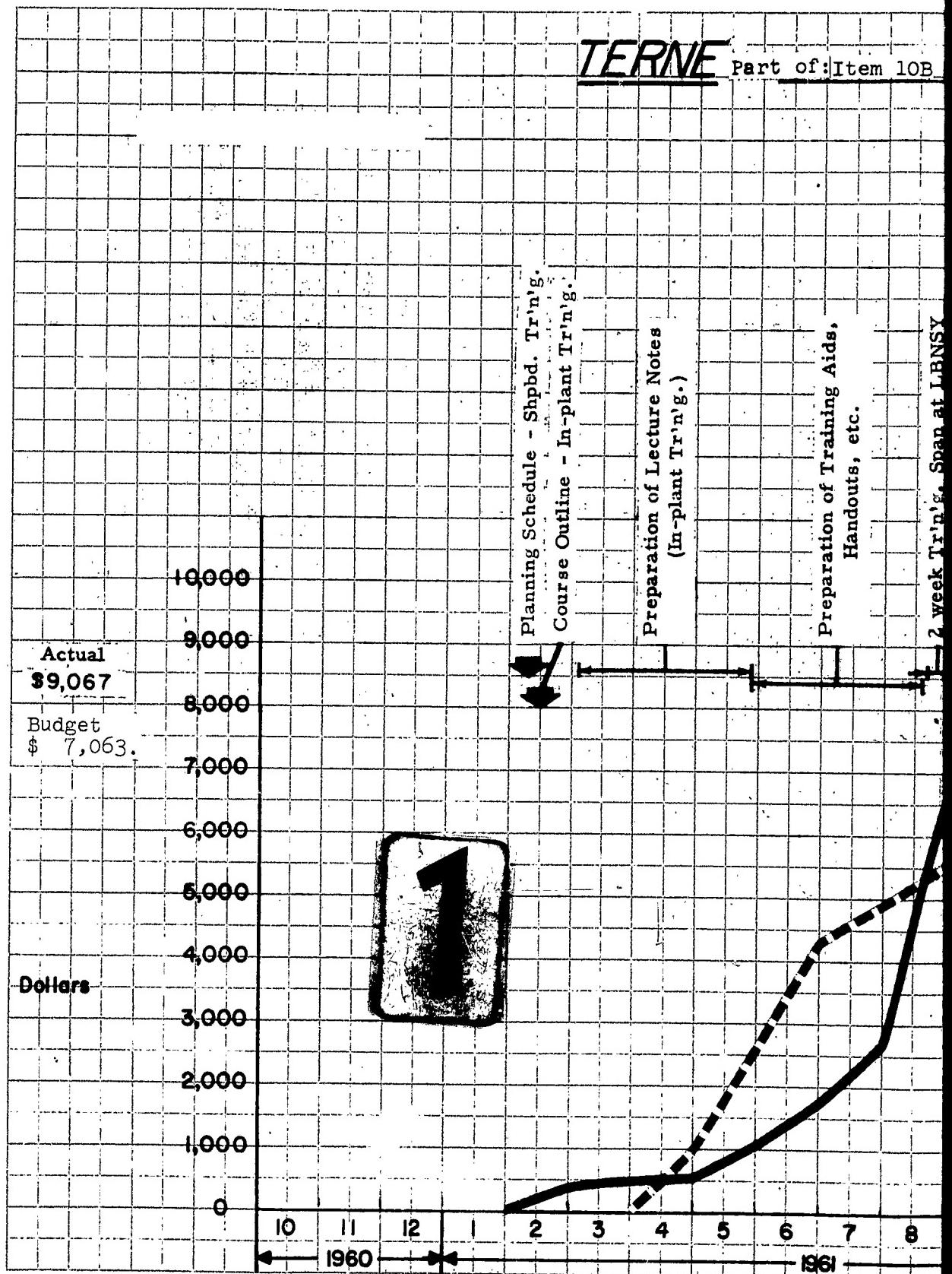
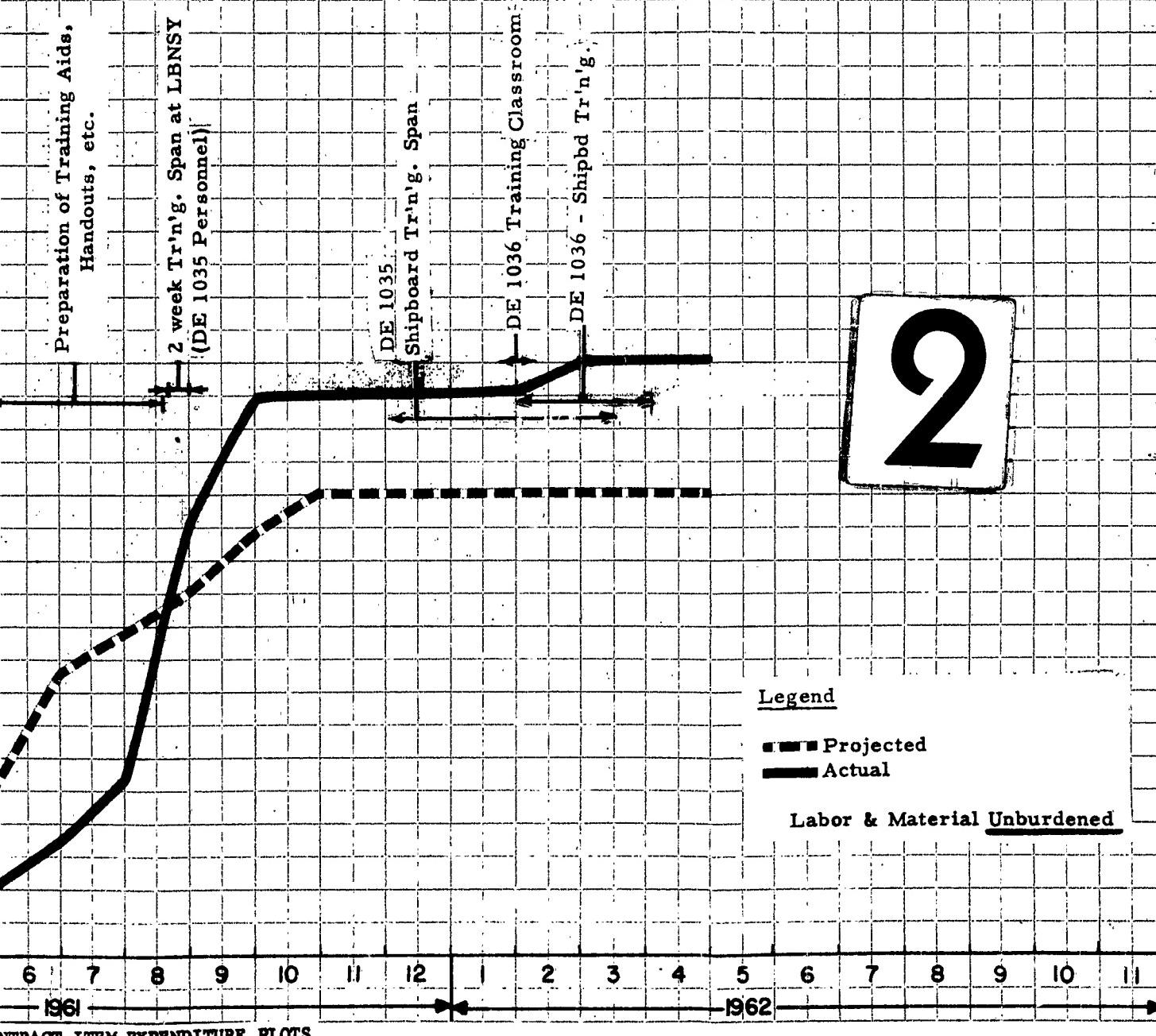


FIGURE 4.14 CONTRACT ITEM EXPEND

of: Item 10B Engineering Services - Installation (Training)

Preparation of Training Aids,
Handouts, etc.



TERNE -

Item 10C Engine

Provide Minimum Eng'g. Coordination
and Follow-Up of the Missile & Missile
Parts Evaluation Program at Naval
Missile Lab., Dahlgren, Va., & Naval
Torpedo Station, Keyport, Wash.

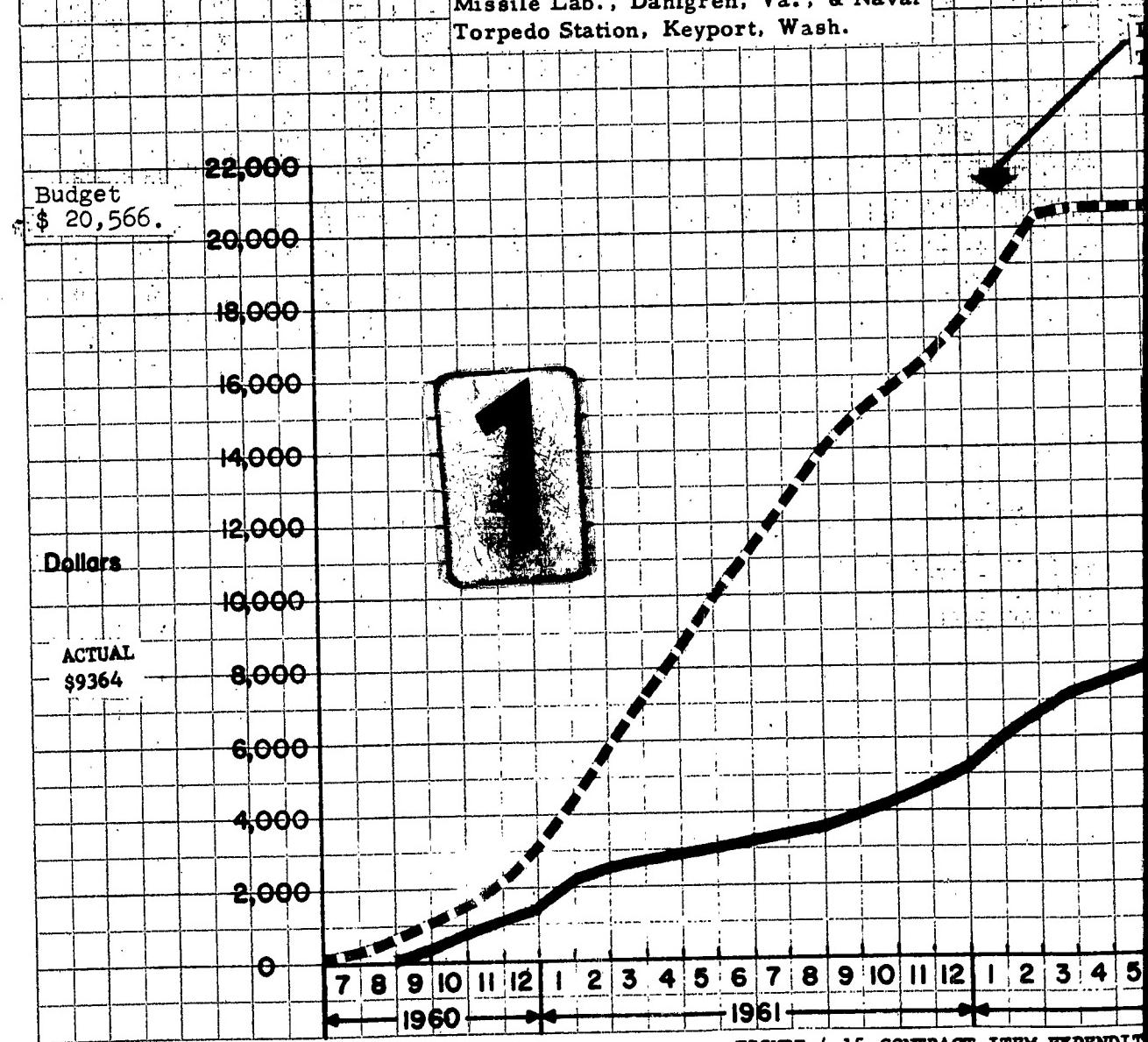
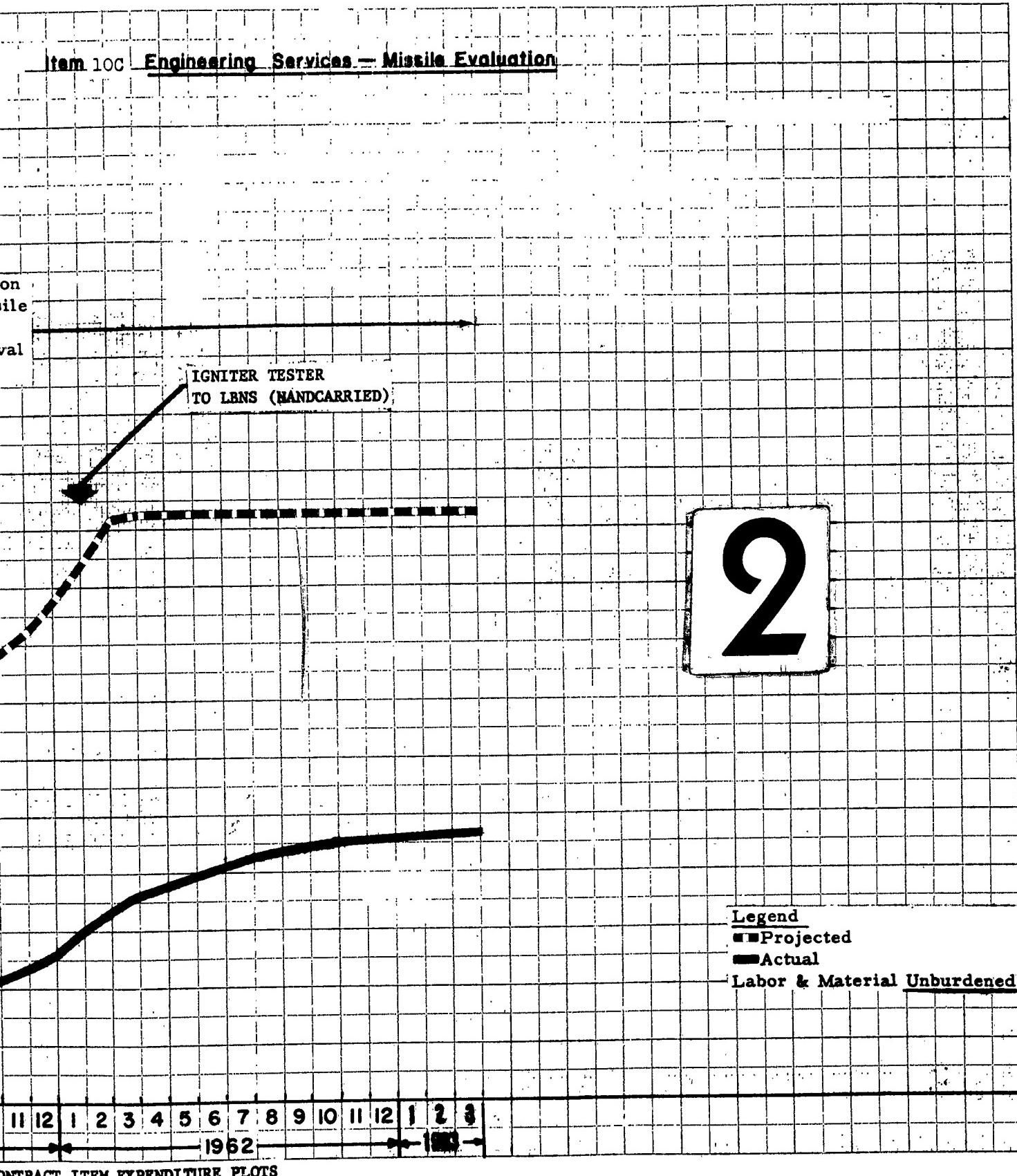


FIGURE 4.15 CONTRACT ITEM EXPENDITURE

Item 10C Engineering Services - Missile Evaluation



TERNE

Item 10D Engineer

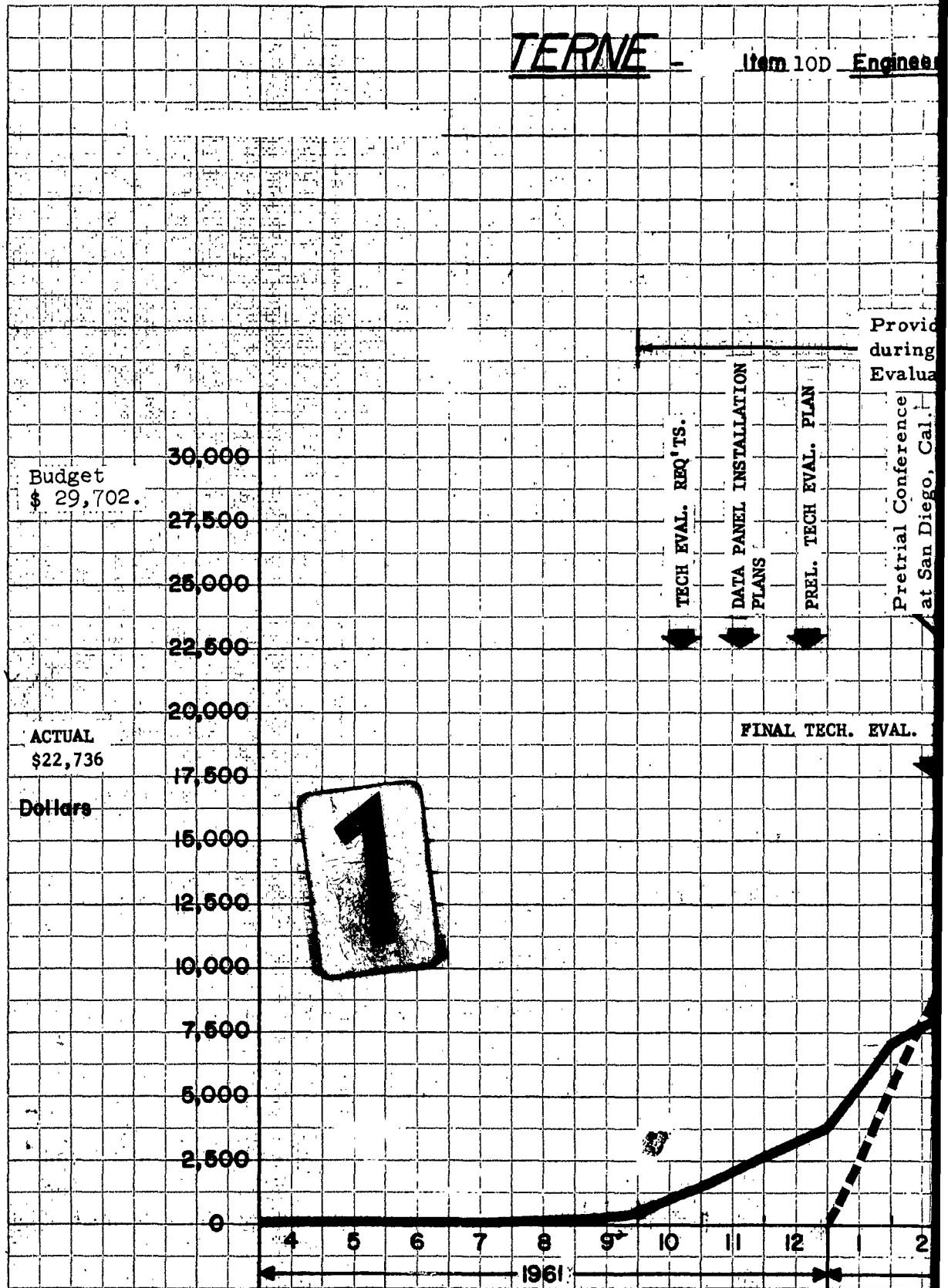
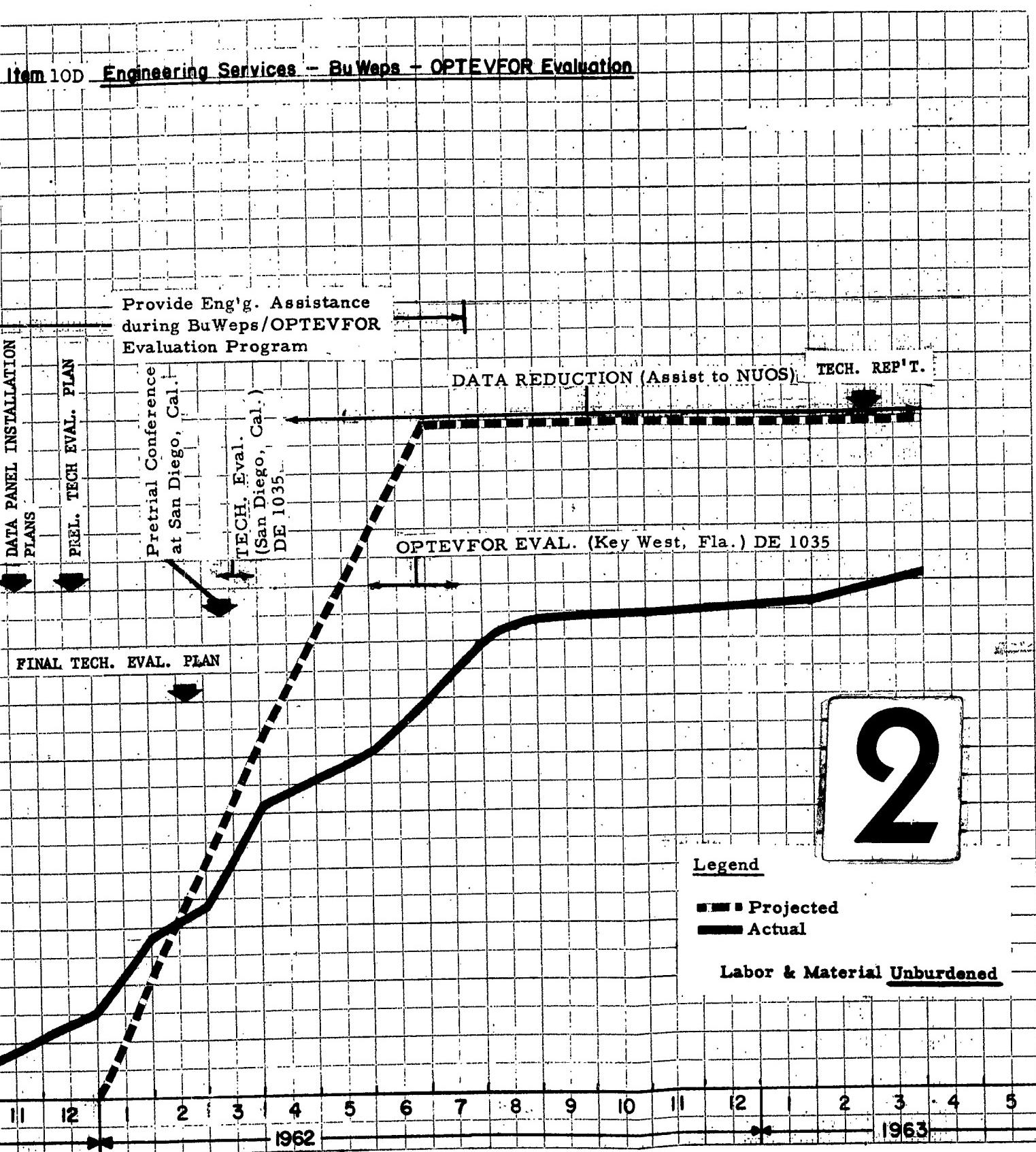


FIGURE 4.16 CONTRACT ITEM

Item 10D Engineering Services - BuWeps - OPTEVFOR Evaluation

RE 4.16 CONTRACT ITEM EXPENDITURE PLOTS

KEUFFEL & ESSER CO., N.Y.

TERNE

Item 10E Eng

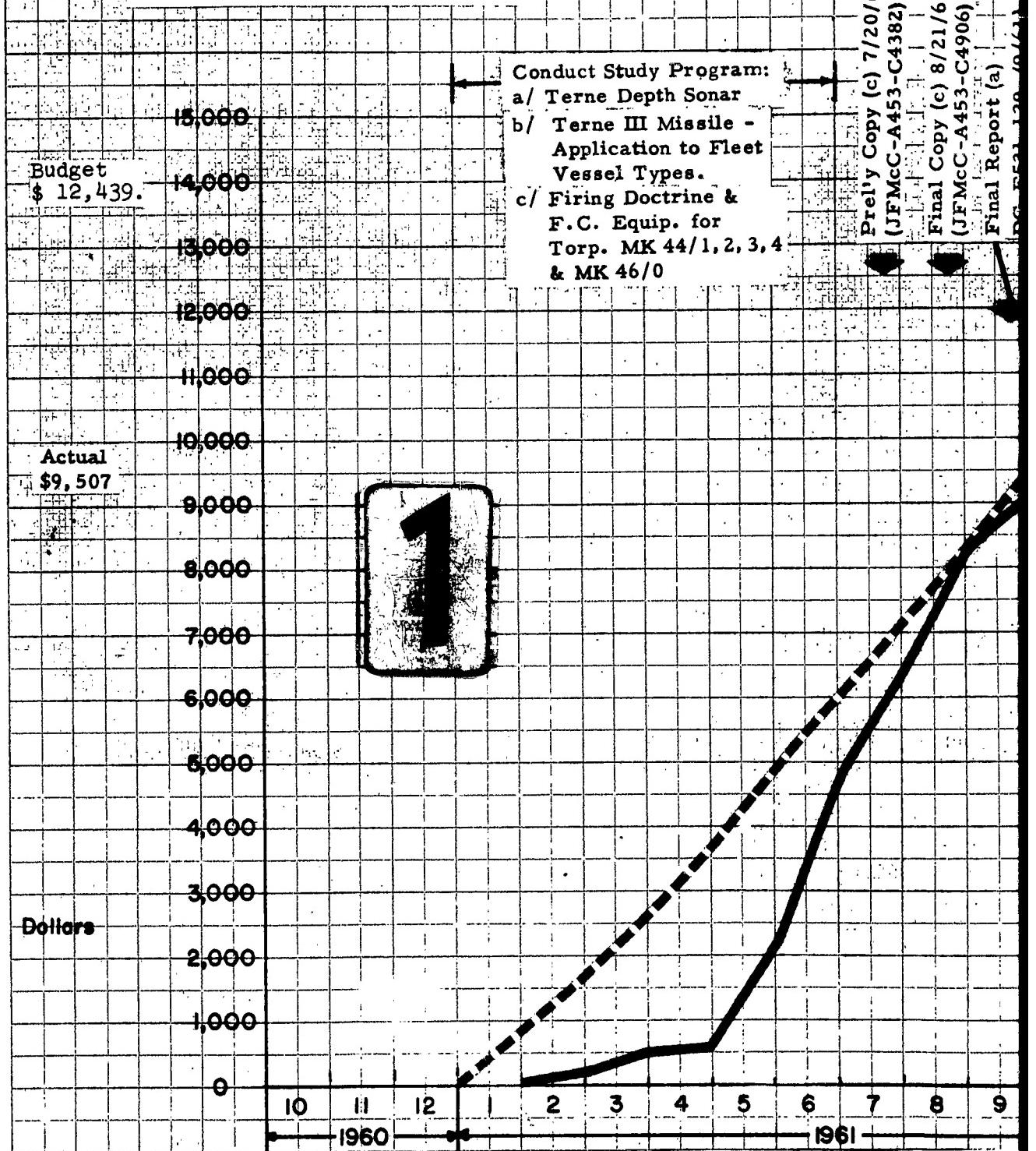


FIGURE 4.17 CONTRACT ITEM EXPEND

Item 10E Engineering Services - Related Studies

Prel'y Copy (c) 7/20/61
 (JFMcC-A453-C4382)

Final Copy (c) 8/21/61
 (JFMcC-A453-C4906).

Final Report (a)
 DG-E531-129 (9/61)
 Master & 25 copies
 (3-1-62)

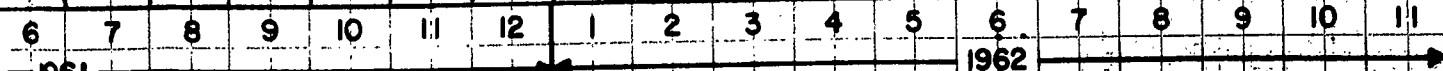
Final Report (b)
 (Req't. Deleted
 from Contract)

2

Legend

■ Projected
 — Actual

Labor & Material Unburdened



CONTRACT ITEM EXPENDITURE PLOTS

KEUFFEL & ESSER CO. N.Y.

TERNE

Item 108 - Lou

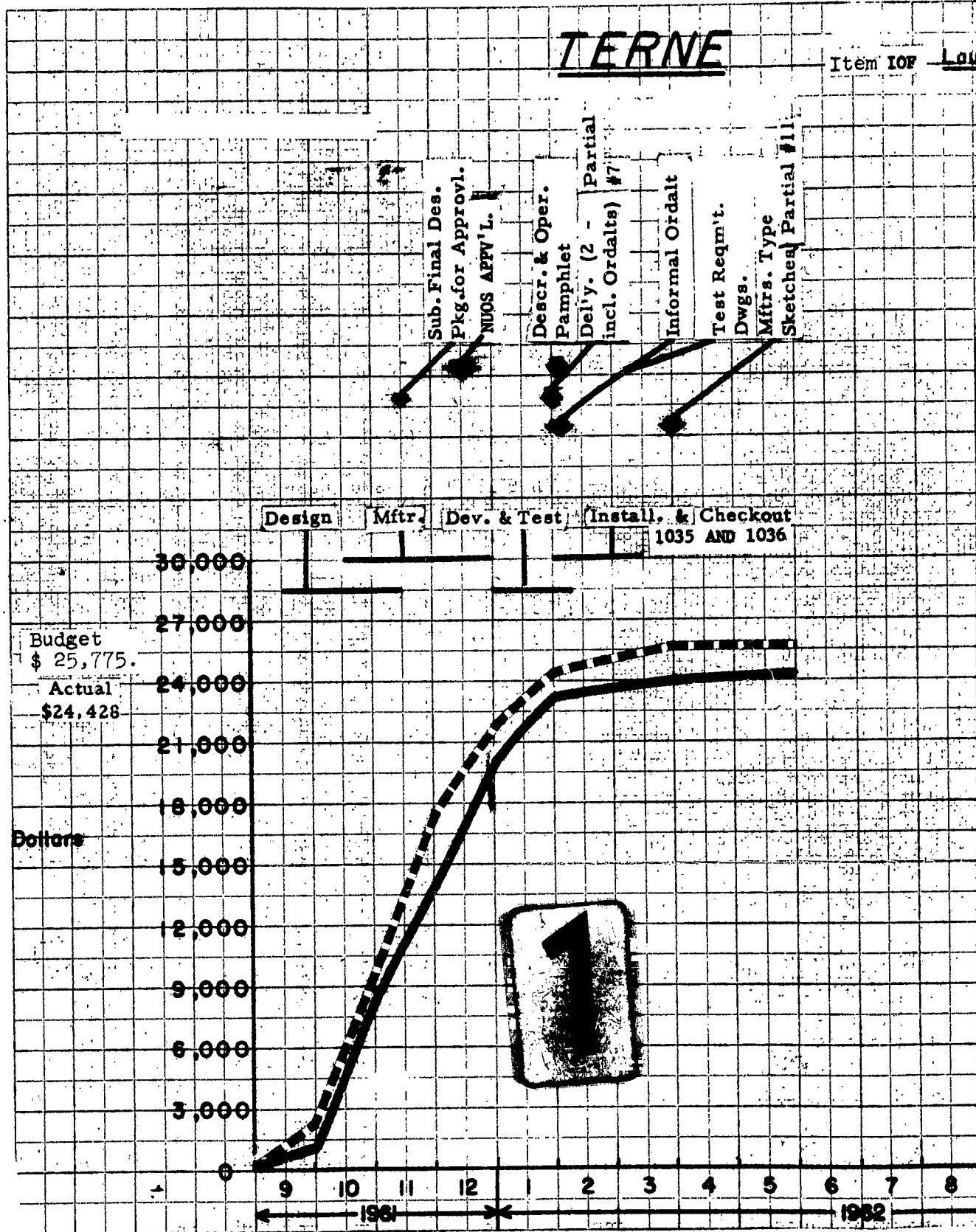


FIGURE 4.18 CONTRACT ITEM EXPENDITURE

Item 10F Launch Range Display Units

Mits. Type
Sketches Partial File

kont
1036

2

Legend

■ Projected

— Actual

Labor & Material Unburdened

5 6 7 8 9 10 11 12

1962

TERNE

Item 10F

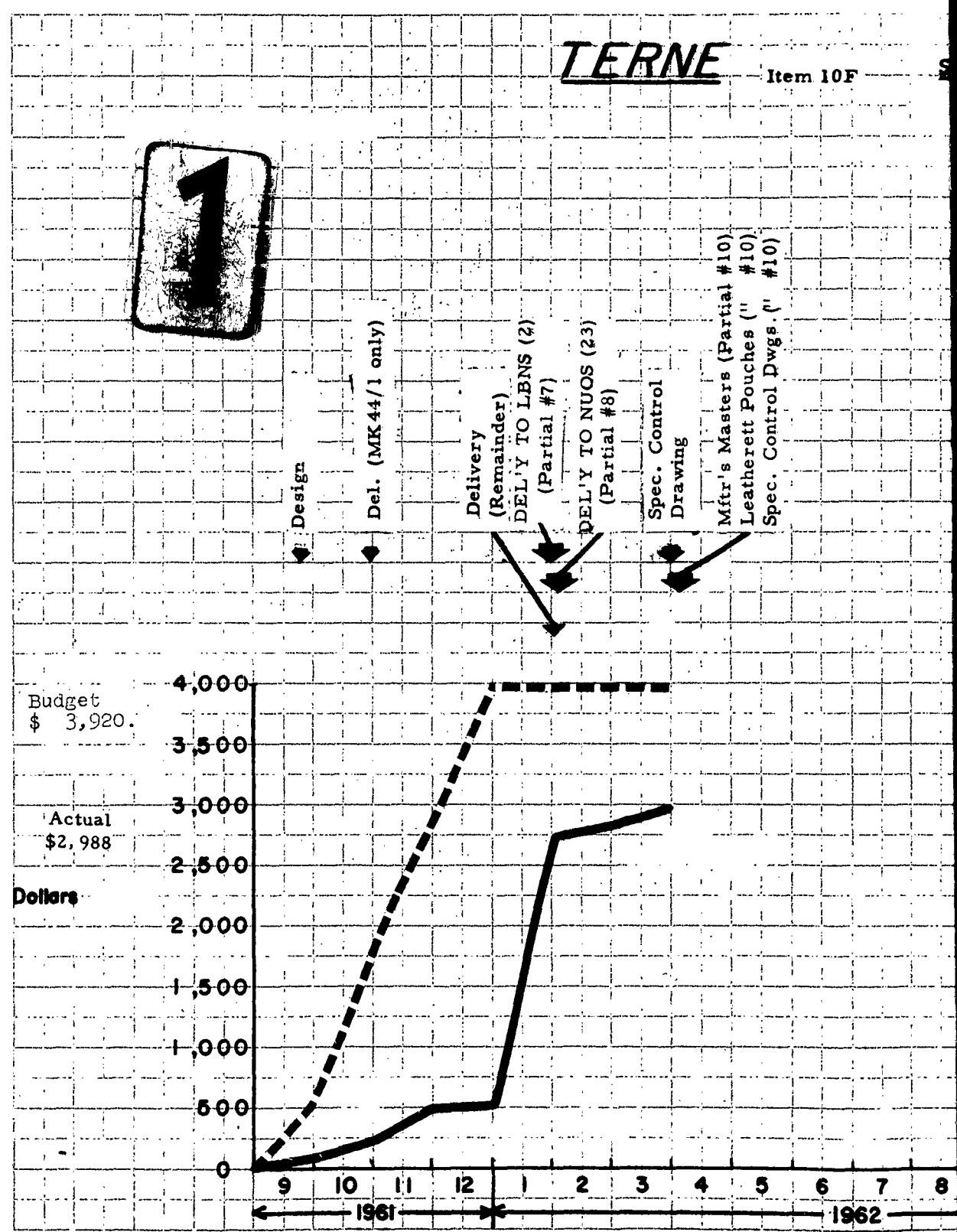


FIGURE 4.19 CONTRACT ITEM EXPENDITURE

Slide Rules

Item 10F

Leatherett Pouches (" #10)
Spec. Control Dwg. (" #10)Legend

- ■ ■ Projected
- ■ ■ Actual
- Labor & Material Unburdened

5 6 7 8 9 10 11 12

1962

TERME Contract - N
Summary Chart - Direct Labor
Estimated vs Actual

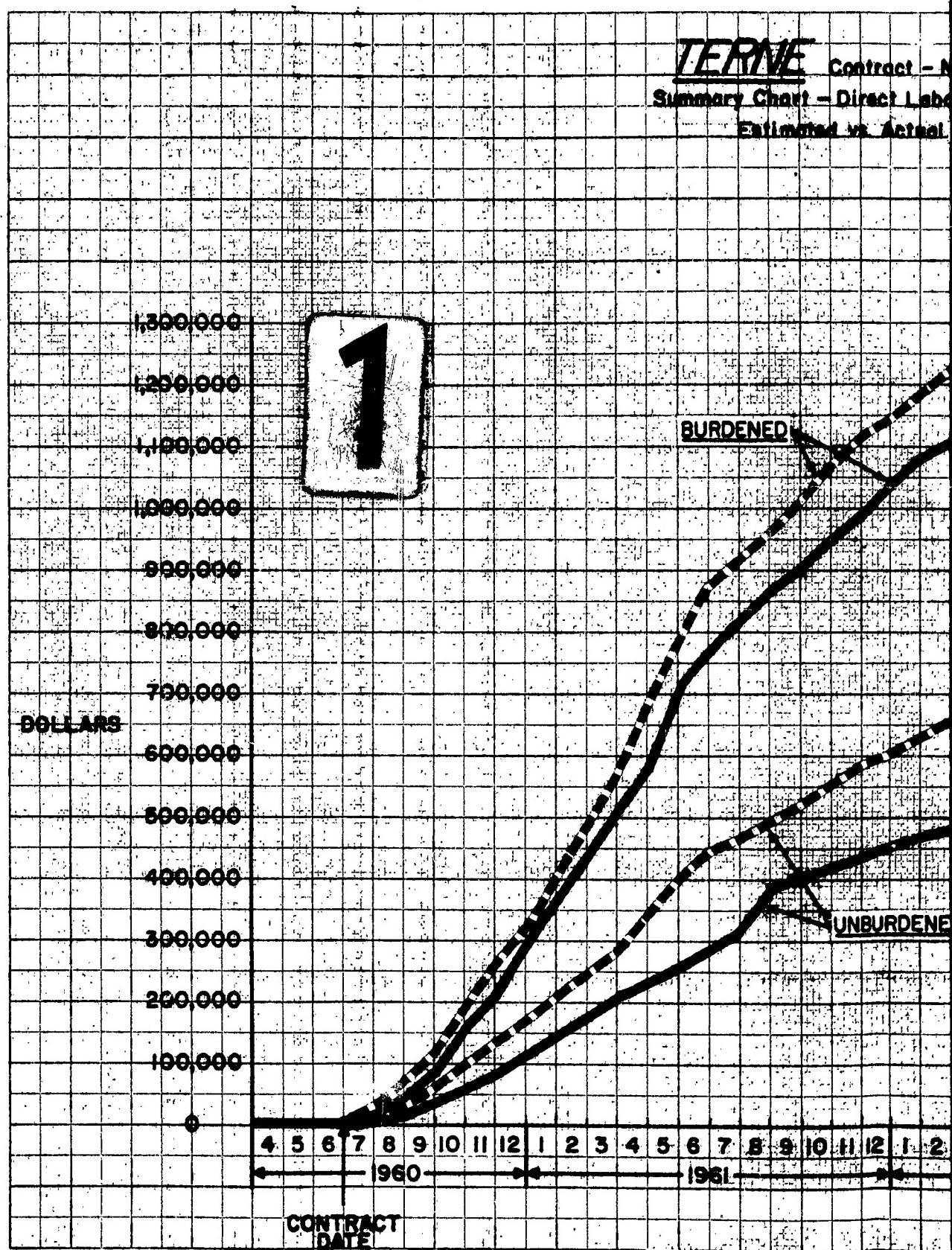
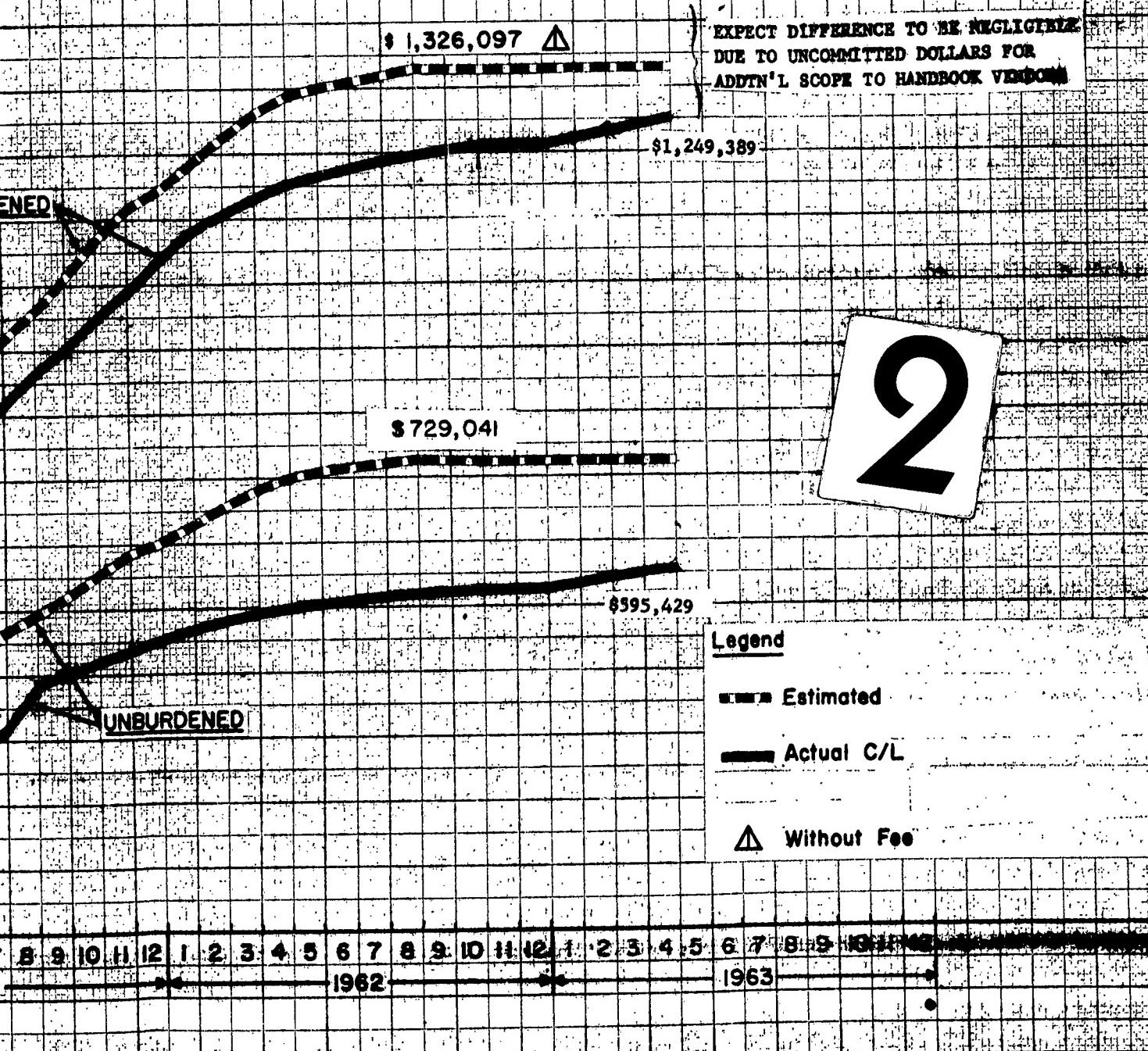


Figure 4.20. OVERALL EXP.

Contract - NI40 (122) 69961B
 Chart - Direct Labor & Material Dollars
 Estimated vs. Actual



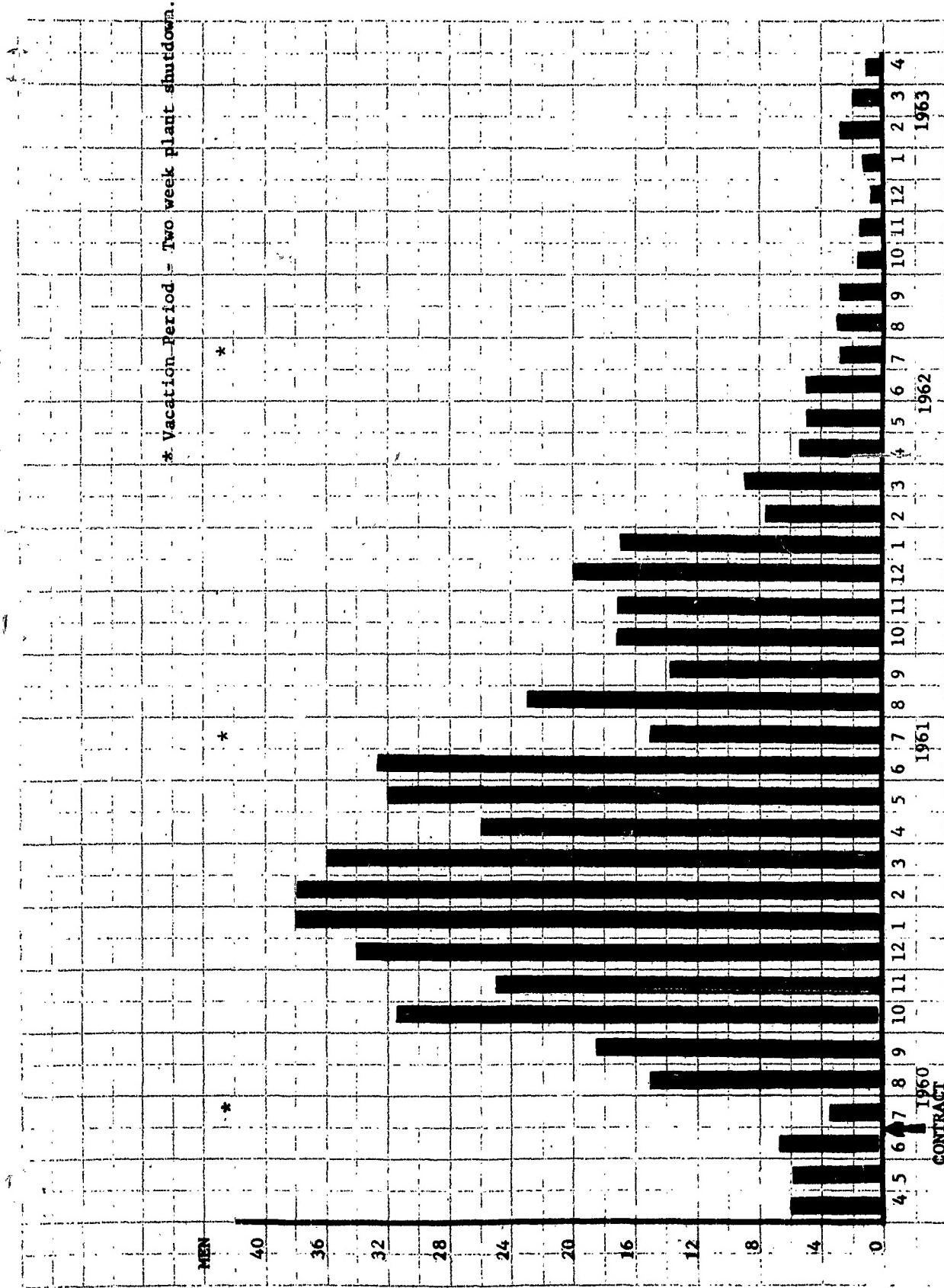


FIGURE 4.21 - PROGRAM MANPOWER UTILIZATION

ENGINEERING

- Overall Program Schedule
- Engineering Work Orders (interim)
- Engineering Operating Work Schedules
- Dollar Expenditure Records (material)
- Weekly Project Status Conference
- Commitment Trouble Reports
- Correlation Listing of Engineering Operating Work Schedules (bimonthly)
- Percent Completion Reports (bimonthly)
- Engineering Work Order Status Reports
- Schedule Commitment Reports (monthly)
- Rate vs Percent Completion Expenditures
- Workload Plots by Contract Item
- Monthly Project Status Reports
- Summary Plot: Manhour Expenditures
- Summary Plot: Actual Dollar Expenditures
- Summary Plot: Planned Workload
- Overall Program Liaison

CONTROLLER'S DEPARTMENT

Budget Sheet
Code Assignments
Estimates to Complete
IBM Cost Analysis



FIGURE 4.22 Project Management

ENGINEERING OPERATIONS

Overall Program Schedule
 Engineering Work Orders (interim budget allocations)
 Engineering Operating Work Schedules
 Dollar Expenditure Records (material dollars, travel and subsistence)
 Weekly Project Status Conferences and Reports
 Commitment Trouble Reports
 Correlation Listing of Engineering Work Orders and Engineering Operating Work Schedules (bimonthly)
 Percent Completion Reports (bimonthly)
 Engineering Work Order Status Reports (monthly)
 Schedule Commitment Reports (monthly)
 Rate vs Percent Completion Expenditure Plots by Contract Item (monthly)
 Workload Plots by Contract Item (monthly)
 Monthly Project Status Reports
 Summary Plot: Manhour Expenditure vs Planned Workload
 Summary Plot: Actual Dollar Expenditure vs Estimated Rate (unburdened)
 Summary Plot: Planned Workload
 Overall Program Liaison

CONTRACTS DEPARTMENT

Contract and Mods
 Master Authorization and Revisions
 Estimate Requests (as required)
 Budget (in conjunction with Controller's Dept.)
 Deliveries
 Reports



FIGURE 4.22 PROGRAM CONTROL

Appendix A

LIST OF PRINCIPAL CONFERENCES

12 November 1959 Arma at NUOS; Newport, R. I.

Purpose: To discuss general ground rules relative to Arma proposal for a study contract to define Norwegian and BUSHIPS-BUORD problem areas, in advance of hardware contract.

18 November 1959 Arma at BUORD, Re U4; Washington, D. C.

Purpose: To discuss the general Terne program and the Terne proposal document.

2 December 1959 Arma at NUOS; Newport, R. I.

Purpose: To discuss study program description and salient details.

10 December 1959 Arma at BUWEPS; Washington, D. C.

Purpose: To review and discuss agenda for first visit to Kongsberg, Norway.

11-20 December 1959 Arma at Kongsberg, Norway

Purpose: See paragraph 3.10.1, Contract item 10 a.

31 December 1959 Arma at BUORD; Washington, D. C.

Purpose: To discuss preliminary Technical Development Plan.

8 January 1960 Arma/NUOS at BUWEPS and BUSHIPS; Washington, D.C.

Purpose: To discuss revisions to Terne "Technical Development Plan" with BUWEPS and BUSHIPS for purpose of including information resulting from first visit to KV.

- 15 January 1960 Arma at BUWEPS; Washington, D. C.
- Purpose: To deliver documents (3) to NUOS at BUWEPS, Washington, D. C. (Phase Plan, TDP, Recommended Documentation for Weapon System W-113)
- 25 January 1960 Arma at ABAC; Washington, D. C.
- Purpose: To brief Chicago Division representatives for preparation of proposal to Arma Division for two (2) switchboards, to discuss arrangements for Presetter requirements and Terne writeup for Navy Information Bulletin.
- 29 January 1960 Arma at BUWEPS-RUDC-3; Washington, D. C.
- Purpose: To discuss Terne Development Program document (TDP).
- 1 March 1960 Arma at Charleston Naval Shipyard, South Carolina
- Purpose: To brief DE 1036 (McMorris) personnel with general details of the Terne Program.
- 11 March 1960 Arma at BUSHIPS, Washington, D. C.
- Purpose: To discuss progress of Terne Program in BUSHIPS and related matters.
- 23-28 March 1960 Arma at Kongsberg, Norway
- Purpose: To exchange technical information between KV, Arma and U.S. authorities regarding technical problems relating to Arma's role in the installation of two Terne systems aboard two U.S. vessels.
- 8 April 1960 Arma at BUSHIPS and BUWEPS; Washington, D. C.
- Purpose: To obtain technical data on Terne Program and to discuss ballistic computer for Torpedoes MK 43, 44, 46.

12 April 1960 Arma at NOTS; Pasadena, California

Purpose: To obtain firm presetting requirements for Torpedoes MK 44 and MK 46.

18 April 1960 Arma at Long Beach Naval Shipyard, California

Purpose: To discuss the Terne Program and Arma's role in the installation of the Terne III system aboard DE 1035 and DE 1036; and preliminary planning and scheduling.

19 April 1960 NUOS at Arma

Purpose: To firm up requirements for the Torpedo Presetter.

2 May 1960 Arma at RUAW-31; Washington, D.C.

Purpose: To expedite processing of foreign visit clearances for Arma personnel to visit Kongsberg Vapenfabrikk.

20 May 1960 Arma at NOTS; Pasadena, California

Purpose: To discuss Torpedo Presetter and Ballistic Computer for Torpedoes MK 43, MK 44, and MK 46, and Terne interrelated areas.

26 May 1960 Arma at NOTS; Pasadena, California

Purpose: To discuss Torpedo Presetter and Ballistic Computer requirements and design concepts prior to preparation of technical proposal.

29 June 1960 Arma at NUOS; Newport, R. I.

Purpose: To establish an agenda for the July 11-28, 1960 conference at KV.

5 July 1960 Tele-Dynamics Division at Arma

Purpose: To discuss matters pertaining to Arma preparation of switchboard guidance plans and related schedule for T-DD switchboard contract with BUSHIPS.

11-28 July 1960 Arma at Kongsberg, Norway

Purpose: To review functional flow diagram of complete system and determine system cabling requirements and power distribution for system. Review installation drawings and sonar requirements and determine requirements for logistic support. In addition: equipment cooling, missile data, instruction books, system operation, drawings and documentation, and equipment tests were discussed.

4 August 1960 NUOS at Arma

Purpose: To discuss technical and administrative details concerning:

1. Torpedo Presetter and Computer
2. SCB changes to DE 1035, DE 1036 re: Dash, VDS, and Mk 37 Torpedo System
3. VDS corrections for attack application
4. Terne studies; vessel size, depth study
5. Handbooks
6. Attack Director Modifications

10 August 1960 Arma/NUOS at NOTS; Pasadena, California

Purpose: To redefine Torpedo Presetter requirements for Torpedoes MK 44 Mods 0 and 1 and to establish requirements for Torpedoes MK 44, Mods 2 and 3.

10 August 1960 Arma/NUOS at Long Beach Naval Shipyard, California

Purpose: To provide engineering assistance to LBNS for Ship Alt analysis.

18-19 August 1960 Arma/NUOS at BUSHIPS; Washington, D. C.

Purpose: To review Terne Program and update BUSHIPS on results of conferences at KV and LBNSYD.

30 August 1960 Arma at Long Beach Naval Shipyard, California

Purpose: To discuss Terne installation, cabling and power.

6 September 1960 Arma at NUOS; Newport, R. I.

Purpose: General technical discussion on all aspects of Terne Program.

14-15 September 1960 Arma at BUSHIPS and BUWEPS; Washington, D.C.

Purpose: General technical discussion of Terne Program relative to conference at LBNSYD and current problems.

22 September 1960 Arma at NUOS; Newport, R. I.

Purpose: To review vendor handbook task, MIL-D-70327 and obtain approval of Torpedo Presetter Preliminary Design Package.

27 September 1960 Arma at BUWEPS; Washington, D.C.

Purpose: To obtain approval of drawing formats as defined in MIL-D-70327.

29 September 1960 Arma at NUOS; Newport, R. I.

Purpose: General contractual discussion and clarification.

3 October 1960 Arma at Kongsberg, Norway

Purpose: General Terne technical conference.

11 October 1960 Arma at Long Beach Naval Shipyard, California

Purpose: Terne planning conference in preparation for visit of KV engineers relative to KV assistance and general technical discussions.

13 October 1960 Tele-Dynamics Division at Arma

Purpose: To provide T-DD with advance information relative to Switchboard Guidance Plans.

19 October 1960 Arma at NUOS; Newport, R. I.

Purpose: To review the approval status of Presetter and Converter Design Packages, Mark and Mod assignments, and Norwegian functional symbols.

19-20 October 1960 Arma at BUSHIPS; Washington, D.C.

Purpose: Conference to review the Arma-prepared Switchboard Guidance Plans with BUSHIPS.

21 October 1960 Arma at NUOS; Newport, R. I.

Purpose: To discuss the Norwegian equipment handbook task and to deliver computer run-out study reports.

25 October 1960 NUOS/Arma/KV at Long Beach Naval Shipyard, California

Purpose: Terne conference with KV and LBNSYD on general technical and interface problems.

14-18 November 1960 Arma at Kongsberg, Norway

Purpose: To initiate Norwegian equipments instruction book data gathering effort.

18 November 1960 Arma at NPO; Brooklyn, N. Y.

Purpose: General discussion and clarification of contract.

22 November 1960 Arma at NUOS; Newport, R. I.

Purpose: To discuss various current problems, Torpedo MK 37 Mod 1 engineering services, and Terne missile and fuze evaluation.

13-15 December 1960 Arma at Kongsberg, Norway

Purpose: Review status of data gathering effort; report of the period November 11, 1960 to December 9, 1960.

22 December 1960 Arma at BUWEPS and BUSHIPS; Washington, D. C.

Purpose: To review Norwegian visits of November and December, 1960 and to discuss related technical areas.

9 January 1961 Arma at NUOS; Newport, R.I.

Purpose: General technical discussions. Agenda for next Kongsberg visit . Presetter increased scope.

17 January 1961 Arma at Tele-Dynamics Division; Philadelphia, Pa.

Purpose: General SWBD technical discussions.

25 January 1961 Bureau of Naval Personnel at Arma

Purpose: To review Arma preliminary planning and to discuss the Terne Training Program in general.

26 January 1961 Tele-Dynamics Division at Arma

Purpose: To review impact of Torpedo MK 37-1 requirements on switchboard.

- 27 January 1961 Arma at BUSHIPS, Code 665; Washington, D.C.
- Purpose:** To exchange general information relative to the switchboard effort.
- 30 January 1961 Arma at Long Beach Naval Shipyard, California
- Purpose:** To review and analyze ShipAlt problems, and to discuss personnel training program.
- 10 February 1961 Arma at NUOS; Newport, R.I.
- Purpose:** To discuss impact of adding Torpedo MK 37/1, and to review agenda for technical conference at KV, Norway, February 20 - March 3, 1961.
- 14-15 February 1961 Arma at BUWEPS and BUSHIPS; Washington, D.C.
- Purpose:** Terne technical conference including discussions on provisioning of spares, status of Terne equipments and sonar cabling.
- 15 February 1961 Tele-Dynamics Division at Arma
- Purpose:** To review Switchboard switching requirements for ASW Weapon System MK 1 Mod 0.
- 28 February 1961 Arma at NUOS; Newport, R. I.
- Purpose:** To deliver the Final Design Approval Package for the Electronic Frequency Converter MK 50 Mod 0, and to discuss missile evaluation programs.
- 21 February-2 March 1961 Arma/NUOS at Kongsberg, Norway
- Purpose:** To review sonar hoist and transducer installation details, final KV drawings, launcher and weather-hood installation. Reviewed additional information for technical manuals, synchro zeroing procedures and schedules.

8 March 1961 Arma at NUOS; Newport, R. I.

Purpose: To report on discussions held at Kongsberg, Norway.

10 March 1961 Arma at BUWEPS and BUSHIPS; Washington, D.C.

Purpose: To review Kongsberg conference with Mr. J. Lacombe (BUWEPS) and Mr. Wagner (BUSHIPS).

13-14 March 1961 NUOS/T-DD and Arma at BUSHIPS; Washington, D.C.

Purpose: To review switchboard program and Switchboard Guidance Plans for DE1035 and DE1036.

21 March 1961 Arma at BUSHIPS, Code 689; Washington, D.C.

Purpose: Review sonar cabling and wire designations.

24 March 1961 Arma at Tele-Dynamics Division; Philadelphia, Pa.

Purpose: To deliver latest switchboard drawings and to review recent revisions.

12 April 1961 NUOS at Arma.

Purpose: Review approval of Switchboard Guidance Plans; Arma DG-E531-96, sheets 1 thru 4.

4-17 April 1961 Arma at Kongsberg, Norway

Purpose: To review instruction book drafts and installation data with KV, and establish installation requirements and engineering services required during training and installation at Long Beach Naval Shipyard.

17-18 April 1961 Arma at NUOS; Newport, R.I.

Purpose: Review discussions held at Kongsberg.

1 May 1961 Arma at NUOS; Newport, R.I.

Purpose: Technical discussions relating to KV, presetter, presetter OCD's and MIL-Specs.

8 May 1961 Arma at Long Beach Naval Shipyard, California

Purpose: Discuss weatherhood and other data from KV conference.

15 May 1961 Arma at NUOS; Newport, R. I.

Purpose: Technical discussions concerning instruction books, FATS, and progress at LBNSYD.

18 May 1961 Arma at T-DD; Philadelphia, Pa.

Purpose: Review of switchboard status and final corrections to Switchboard Guidance Plans.

23 May 1961 Arma at BUWEPS and BUSHIPS; Washington, D.C.

Purpose: Technical review of Terne program.

25 May 1961 Arma at NUOS; Newport, R. I.

Purpose: To discuss missile evaluation programs at Keyport, Washington; Dahlgren, Virginia; and NUOS, Newport.

25-26 May 1961 T-DD at Arma

Purpose: Review nomenclature for switchboard panel layouts.

30 May-1 June 1961 Arma at Long Beach Naval Shipyard, California

Purpose: Pre-installation planning conference for exchange of information.

31 May - 9 June 1961 Arma/NUOS at Kongsberg, Norway

- Purpose: To review production and acceptance test status, delivery schedule, shipping and packaging, final documentation, and installation details.
- 7 June 1961 Arma/BUWEPS/NUOS at Dahlgren, Virginia
- Purpose: Conference to discuss the technical details of the Terne missile evaluation.
- 14 June 1961 Arma at NUOS; Newport, R. I.
- Purpose: Planning conference relative to shipboard checkout of Terne system.
- 19 June 1961 Arma at NUOS; Newport, R. I.
- Purpose: To re-submit the FAT for the Electronic Frequency Converter MK 50/0, and to discuss the missile evaluation programs at Keyport and Dahlgren.
- 27 June 1961 Arma at Long Beach Naval Shipyard, California
- Purpose: Discussion of training and KV services required during installation.
- 12 July 1961 NUOS at Arma
- Purpose: Discussion and review of Torpedo Presetter documentation status.
- 14 July 1961 Arma at NUOS; Newport, R. I.
- Purpose: Deliver one set of KV instruction books and proposed PPL. Discussed mechanical aid for over-the-side torpedoes.
- 3 August 1961 Arma at NUOS; Newport, R. I.
- Purpose: Technical discussions concerning training and KV services.

- 10 August 1961 Arma at T-DD; Philadelphia, Pa.
Purpose: Discuss training at LBNSYD and switchboard status.
- 15 August 1961 Arma at BUWEPS and BUSHIPS; Washington, D. C.
Purpose: Review status of Terne program.
- 20 August - 9 September 1961 Arma at Long Beach Naval Shipyard, Calif.
Purpose: Conducted classroom training program for vessel and shipyard personnel.
- 31 August 1961 Arma at Torpedo Station, Keyport, Washington
Purpose: To discuss the results of the first five firings of the Terne Exercise Rocket MK 4.
- 18 September 1961 Arma at NUOS; Newport, R. I.
Purpose: Discussion of instruction books and review of KV documentation.
- 27 September 1961 Arma at NUOS, Newport, R. I., . . .
Purpose: Discuss Keyport preliminary firing results.
- 28 September 1961 Arma at NUOS; Newport, R. I.
Purpose: Review plans for BUWEPS shipboard evaluation of Terne.
- 4 October 1961 Arma at NUOS; Newport, R. I.
Purpose: Discuss system book, and repair and maintenance data.
- 9-13 October 1961 Arma at LBNSYD, California
Purpose: To review installation progress and to provide engineering assistance.

19 October 1961 Arma at NUOS; Newport, R. I.

Purpose: Review preliminary operational plans for BUWEPS shipboard evaluation of Terne.

25 October 1961 Arma at NUOS; Newport, R. I.

Purpose: Discussion of increased scope for mechanical aids for over-the-side torpedoes and system book.

30 October-14 December 1961 Arma at LBNSYD, California

Purpose: Provide engineering assistance during shipboard installation and checkout of Terne system on DE 1035.

2 November 1961 - 2 April 1962 Arma at LBNSYD, California

Purpose: Provide engineering assistance during shipboard installation and checkout of Terne system on DE 1035 and DE 1036.

7-10 November 1961 Arma at LBNSYD, California

Purpose: Deliver updated functional schematics, cable diagrams, and data panel cabling.

4 December 1961 Arma at NUOS; Newport, R.I.

Purpose: Discuss Launch Range Display Unit design approval package, and the adequacy of the fuze test unit information.

8 December 1961 Arma at NUOS; Newport, R. I.

Purpose: Discuss the technical evaluation.

18-21 December 1961 Arma at LBNSYD, California

Purpose: Discussions relative to shipboard training, and installation problems.

3 January 1962 Arma at NUOS; Newport, R. I.

Purpose: Review installation problems remaining on DE 1035 and plans for BUWEPS Technical Evaluation.

5 January 1962 Arma at NUOS; Newport, R. I.

Purpose: Discuss Data Panel interfaces.

8-17 January 1962 Arma at LBNSYD, California

Purpose: Review status of Terne installation on DE 1035 and DE 1036.

24 January-17 February 1962 Arma at LBNSYD, California

Purpose: Provide engineering assistance during Terne installation and checkout on DE 1035 and DE 1036, and conduct classroom training program for DE 1036 personnel.

25 January 1962 Arma at Tele-Dynamics; Philadelphia, Pa.

Purpose: Review modifications required to UBFC Switchboard as determined during installation checkout aboard DE 1035.

27 February- 7 March 1962 Arma at Keyport, Washington

Purpose: To provide engineering assistance during alignment tests of Terne system at Dabob Bay.

8, 9 March 1962 Arma at LBNSYD, California

Purpose: Review status of Terne installation on DE 1036.

9 March 1962 Arma at Dahlgren, Virginia

Purpose: To discuss Dahlgren Terne Missile Evaluation results.

10-25 March 1962 Arma at San Diego, California

Purpose: Provide engineering assistance during BUWEPS Evaluation of Terne on DE 1035.

26 March-4 April 1962 Arma at LBNSYD, California

Purpose: Provide assistance during final checkout of Terne system on DE 1036.

10 April 1962 Arma at NUOS; Newport, R. I.

Purpose: Discuss results of BUWEPS Technical Evaluation, data reduction, and deficiencies remaining in Terne system on DE 1035 and DE 1036.

16-27 April 1962 Arma at: (1) Long Beach Naval Shipyard, California
(2) Naval Repair Facility; San Diego, California

Purpose: To provide engineering assistance during shipyard availability of DE 1035 (LBNSYD) and DE 1036 (NRF, San Diego). Replacement of OSS Synchro with new type, 31 TR6, in Computer MK 142.

17-18 April 1962 Arma at NUOS; Newport, R. I.

Purpose: To discuss the NUOS program for analyzing BUWEPS Technical Evaluation data.

24 April 1962 Arma at NUOS; Newport, R. I.

Purpose: To discuss Norwegian equipment maintenance data generation and related topics.

2-3 May 1962 Arma at NUOS; Newport, R. I.

Purpose: To check preliminary results of BUWEPS Technical Evaluation data reduction at NUOS and program progress.

10 May 1962 Arma at NUOS; Newport, R. I.

Purpose: To discuss plans and requirements for OPTEVFOR Operational Evaluation.

11 May 1962 Arma at NUOS; Newport, R. I.

Purpose: To review problem areas relating to data reduction of BUWEPS Technical Evaluation data by NUOS.

31 May - 6 June 1962 Arma at TEVDET, Key West, Fla.

Purpose: Change computer underwater ballistics, check of OSS synchro and Launch Range Display Unit, and assist in repair of Terne sonar transducer Train/Tilt mechanism aboard DE 1035.

Purpose: Change computer underwater ballistics and provide engineering assistance relative to Terne installation on DE 1036.

13 June 1962 Arma/NUOS at Dahlgren, Virginia

Purpose: To discuss "Project Hero" (RF radiation hazard) results on Terne missile, and technical problems concerning the Terne fuze.

15 June 1962 Arma at NUOS; Newport, R. I.

Purpose: To discuss maintenance and repair, and spares provisioning for Terne equipments.

25 June - 20 July 1962 Arma at TEVDET; Key West, Fla.

Purpose: To provide engineering assistance during OPTEVFOR Evaluation on DE 1035. Change Terne weapon pattern spacing and run dynamic tests of overall system.

- 3 July 1962 Arma, NUOS, KV, and Dahlgren personnel at BUWEPS; Washington, D. C.
- Purpose: To discuss Terne Fuze technical problems relative to Dahlgren Naval Weapons Laboratory findings.
- 9 August 1962 Arma at BUWEPS; Washington, D. C.
- Purpose: Discuss OPTEVFOR Evaluation and BUWEPS plans for maintaining the Terne system.
- 14 August 1962 Arma at NUOS; Newport, R. I.
- Purpose: Summary meeting to review outstanding problems, including lack of KV maintenance data for equipment manuals and existing system design deficiencies.
- 23 August 1962 Arma at NUOS; Newport, R. I.
- Purpose: To review outstanding technical problems including obtaining information from KV and discuss Terne final report.
- 12 September 1962 Arma at NUOS; Newport, R. I.
- Purpose: Discuss visit to KV for final status, and discussion of maintenance data.
- 11 October 1962 Arma/NUOS/BUWEP personnel at NWL; Dahlgren, Va.
- Purpose: To discuss the re-testing of the Terne fuzes for safety evaluation.
- 26 October 1962 Arma at BUWEPS; Washington, D.C.
- Purpose: Discuss operation of Terne sonar.
- 7 January 1963 Arma at NUOS; Newport, R. I.
- Purpose: Discuss fuze test set and final project status.

15 March 1963 Arma at NUOS; Newport, R. I.
Purpose: Delivered wood mockup of launcher and loading house.

26 March 1963 Arma at NUOS; Newport, R. I.
Purpose: Discuss Arma evaluation report and final report schedule.

10 April 1963 Arma at NUOS; Newport, R. I.
Purpose: Discuss draft of Terne final report.

REVIEW OF FINAL DOCUMENTATION TERNE III EQUIPMENT

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Appendix E
Page 1

REVIEW OF FINAL DOCUMENTATION		TERNE III EQUIPMENT		DRAWINGS - CONFIDENTIAL	
Functional Diagram	(Gear Diagram)	Mechanical Diagram	Electrical Diagram	Internal Wiring Diagram	External Wiring Diagram
Position Indicator MK 99 Mod 0	yes	yes	yes	yes	yes
Firing Panel MK 262 Mod 0	yes	yes	yes	yes	yes
Rocket Thrown Depth Charge Launcher MK 157 Mod 0	yes	yes	yes	yes	yes
Loading House Equipment		Control Panel MK 265 Mod 0	yes	yes	yes
Electronic Cont. Amplifier		yes	yes	yes	yes

For Notes see page 1

TERME III EQUIPMENT
REVIEW OF FINAL DOCUMENTATION

DRAWINGS - CONFIDENTIAL		REVIEW OF FINAL DOCUMENTATION									
		TERME III EQUIPMENT									
Amplifier Generator Set MK 41 Mod 0	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Battery Charger MK 13 Mod 0	yes	yes	yes	yes	yes	yes	yes	yes	no	no	yes ⁽¹⁾
Battery Box Mk 18 Mod 0	yes	yes	yes	yes	yes	yes	yes	yes	no	no	no
Service Ring Mk 1 Mod 0	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Rocket Hydraulic Hoist MK 12 Mod 0	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Dud-Remington Indicator Panel Mk 267 Mod 0	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Manual Control Panel Mk 266 Mod 0	yes	yes	yes	yes	yes	yes	yes	yes	no	no	yes
Rocket Hoist Hydraulic Pump MK 8 Mod 0	yes	yes	yes	yes	yes	yes	yes	yes	no	no	yes
Depth Charge Loading Pallets MK 10 Mod 0 & 1	yes	yes	yes	yes	yes	yes	yes	yes	no	no	yes
Depth Charge Loading Hatch MK 1 Mod 0	yes	yes	yes	yes	yes	yes	yes	yes	no	no	yes
Blast Deflector MK 1 Mod 0	yes	yes	yes	yes	yes	yes	yes	yes	no	no	yes
Missile											
Rocket Thrown Depth Charge MK 3 Mod 0	yes	yes	yes	yes	yes	yes	yes	yes	no	no	yes ⁽¹⁾
Rocket Thrown Dummy Depth Charge MK 3 Mod 0	yes	yes	yes	yes	yes	yes	yes	yes	no	no	no

FOR NOTES see page 4

REVIEW OF FINAL DOCUMENTATION

TERNE III EQUIPMENT

DRAWINGS - CONFIDENTIAL

Missile (Continued)	Light Exercise-Missile	yes	yes	yes	yes	no	yes	no	no	yes	no
Test Equipment for Terne Fuze	no	no	no	no	yes ⁽³⁾	no	-	-	no	-	-
Dud-Jettisoning Rocket MK 1 Mod 0	yes	yes	yes	yes	yes	no	-	-	no	yes	-
Dud-Jettisoning Unit MK 110 Mod 0	yes	yes	yes	yes	yes	no	-	-	no	yes	-
Dud-Jettisoning Unit MK 110 Mod 0	yes	yes	yes	yes	yes	no	-	-	no	-	-
Air Conditioning Equipment											
Air Conditioning Cabinet MK 4 Mod 0	yes	yes	yes	yes	yes	no	-	-	no	yes	-
Air Conditioning Cabinet MK 5 Mod 0	yes	yes	yes	yes	yes	no	-	-	no	yes	-
Power Driven Reciprocating Compressor MK 29 Mod 0	yes	yes	yes	yes	yes	no	-	-	no	yes	-
Power Driven Reciprocating MK 30 Mod 0	yes	yes	yes	yes	yes	yes	no	-	no	yes	-
Remote Temperature Indicator	yes	yes	yes	yes ⁽²⁾	yes	yes	yes	-	no	yes	-
Motor Driven Generator Set 42 Mod 0 (with associated starter, motor, voltage regulator and speed regulator)	yes	yes	yes	yes	yes	no	-	-	no	yes	-

DRAWINGS - CONFIDENTIAL

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REVIEW OF DOCUMENTATION

REF ID: A1100000000000000000000000000000

TERNE III EQUIPMENT		VIEW OF DOCUMENTATION					
		Functional Diagram					
Indicator Panel MK 263 Mod 0	yes	yes	yes	yes	yes	no	no
Power Distribution Panel MK 261 Mod 0	yes	yes	yes	yes	yes	no	no
Terminal Box MK 1 Mod 0 and MK 2 Mod 0	yes	yes	yes	yes	yes	no	no
Mechanical Diagram (Gear Diagram)	yes	yes	yes	yes	yes	no	no
Electrical Schematic Diagram	yes	yes	yes	yes	yes	no	no
Internal Wiring Diagram Extremal Winding Diagram	yes	yes	yes	yes	yes	no	no
Thermal Distribution and Outline Details (Repair Parts)	yes	yes	yes	yes	yes	no	no
Material Specification (Repair Parts)	yes	yes	yes	yes	yes	no	no
Procedure Inspection Only Procedure Methods (Milestone and Processess, and Procedure Tests)	-	-	-	-	-	no	no
Tube and Semiconductor Accesories (Milestone and Processess, and Procedure Tests)	-	-	-	-	-	no	no
Rotating Components List Illustrated Components List	-	-	-	-	-	yes	yes
Repair Parts Lists Handling Lists	-	-	-	-	-	yes	yes
Instructions Shipping and Storage	-	-	-	-	-	-	-

NOTE C.

General - a yes answer indicates that material has been furnished and is satisfactory, while a yes (1) answer with a note indicates that material has been furnished but is unsatisfactory for reasons given in the note. A NC answer indicates material has not been furnished. Line indicates column not applicable.

- (1) Lists are incomplete in that they do not cover the entire system, & do not give electrical descriptions and omit the manufacturers part numbers.

(2) Reference designations missing

(3) Inadequate - only sketch is furnished.

(4) No drawing for MZ test unit

(5) No drawing for sector gear cover and single and double contact assembly.

(6) No drawing furnished.